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TRANSACTIONS

OF THE

AMERICAN PHILOSOPHICAL SOCIETY

HELD AT PHILADELPHIA
FOR PROMOTING USEFUL KNOWLEDGE

NEW SERIES—VOLUME XXXIV, PART III

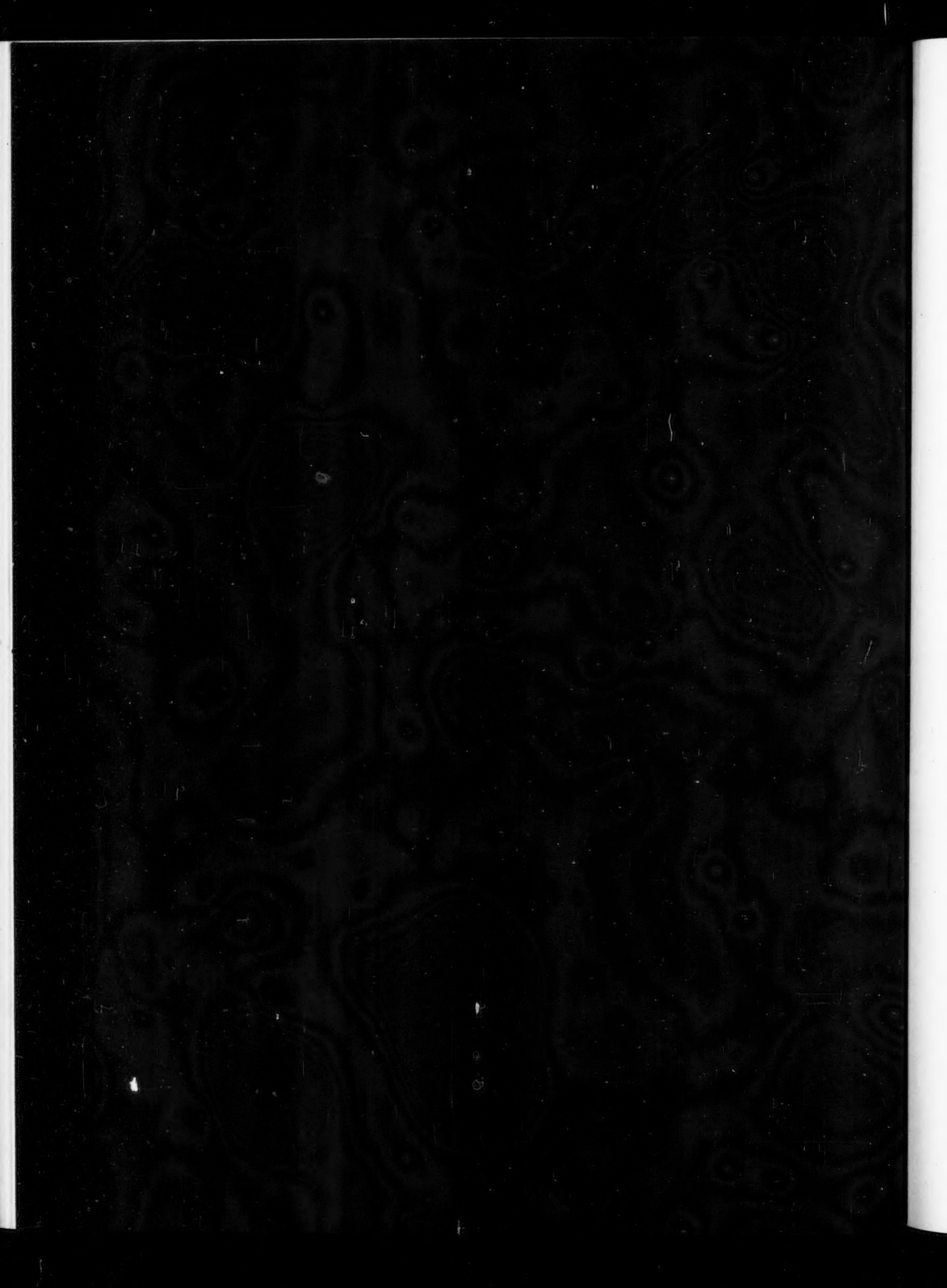
THE MAMMALIA OF THE DUCHESNE RIVER OLIGOCENE

WILLIAM B. SCOTT

Blair Professor Emeritus of Geology
Princeton University

THE AMERICAN PHILOSOPHICAL SOCIETY
INDEPENDENCE SQUARE
PHILADELPHIA 6

MARCH, 1945



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THE MAMMALIA OF THE DUCHESNE RIVER OLIGOCENE

WILLIAM BERRYMAN SCOTT

STRATIGRAPHIC INTRODUCTION

The succession of sandstones and clays which Peterson and Kay named *Duchesne River* lies, in apparent conformity, upon the upper Uinta (Myton substage = Horizon C), though with a marked change in color and in the nature of the contained fossils. The northern border of the formation displays an unconformity by overlap, the Duchesne River beds extending over upon older rocks, Triassic and Jurassic, with very strongly marked angular unconformity. It had always been taken for granted, because of complete ignorance of their fossils, that these strata formed a part of the Uinta Eocene, for they are nearly barren and fossils are exceedingly rare. Almost all our knowledge of the Duchesne River mammals is due to the labors of the Carnegie Museum staff; with a few more or less doubtful exceptions, all the known material is preserved in that museum. Messrs. Peterson and Kay and Dr. John Clark labored strenuously, season after season, in the apparently thankless task of gathering the scanty remains of this fauna, which has proved to be of the utmost interest.

To the extreme kindness of Dr. A. Avinoff, Director, I owe the opportunity of studying this unique collection. Somewhat abbreviated quotations from the papers of Messrs. Peterson and Kay will form a suitable introduction to a study of the fauna.

The formation under discussion is a long and rather narrow belt along the southern base of the Uinta range. It has an extent of approximately eighty miles from east to west, reaching the foothills of the Wasatch range westward; while to the east it extends close to the Colorado-Utah state-line. In a north-south direction the formation seldom exceeds twelve to fifteen miles.

In looking at the eroded faces of the stratigraphic mass the panorama appears as of a pale brick-red. There are many other colors, but the red predominates. Along the southern borders of these upper red beds the strata have a northward and slightly westward dip of from two to four degrees. In proceeding northward through the Basin this dip constantly decreases, especially in the region where the section was made. At a point some three to four miles north of White River the strata become horizontal and very soon there is a noticeable southward dip, thus forming a syncline in this region of the Basin. The extreme southward dip observed along the northern contacts with the base of the Uinta range is seldom over twelve to fifteen degrees.

Lithologically the strata in the region, through which the geological section was taken, are made up, for the most part, of soft and hard sandstones, often enclosing lenses of clay. These sandstones alternate with soft and indurated layers of strongly arenaceous clays. Along the northern border of the Basin are numerous intercalations of masses of conglomerates of finer and coarser texture. These layers of conglomerates are sometimes twenty to thirty feet thick and of considerable geographic extent.

The most intensive search by Peterson (1893–95, 1912, 1929–30), Douglass (1907–29), Riggs (1910), and Kay (1928–30), revealed no clear stratigraphic break between the upper red beds of the Uinta [*i. e.* Duchesne River] and horizon C. . . . Furthermore the lithological gradation, color, and other conditions, along the course of the cross-section made through the Basin, are so gradual from the lower to the higher strata that it becomes extremely difficult to separate the two horizons. The exposures of the lower red beds (top of horizon C), to the west of where the section was made, or in the Duchesne Valley, are, however, capped by a decided hard banding of sandstone, which is quite persistent in the middle region and western end of the Basin. At Point Randlette about three miles above the junction of the Duchesne and the Uinta rivers, on the north bank of the Uinta, the upper part of horizon C is capped with a brown sandstone some ten to twenty feet thick. To the east of this point (Point Randlette) it is possible to trace this horizon to the north of "Pelican Lake" or the northern rim of "Leota Basin," thence crossing the region where the cross-section is taken . . . on Green River between the Baser and Leota bends of Green River . . .

From Point Randlette westward, the sandstones overlying horizon C are clearly distinct and more easily traced. They weather out to characteristic reddish brown cliffs along the streams and on the divides between Lake Fork, "Dry Gulch," Duchesne, and the course of other rivers. In places the sandstones are fine-grained; in other places coarse, with a tendency to become conglomerates. Cross-bedding is often shown, indicating stream action. In a lithological sense these Upper Uinta sandstones are distinctly different from the lower formations in the middle and western part of the Basin. There is more sandstone, less clay, and the sedimentary mass, as a whole, has less vertical thickness. There was, however, no distinct break found between horizon C and the Upper Uinta sediments along the watercourses and divides here mentioned. In the study and measurements of the strata from south to north further east in the Basin, where the section was taken, we are in fact forced to temporarily conclude that the entire tertiary sedimentation of the Uinta Basin including the uppermost beds, went on continuously.

In dealing with these uppermost beds from a faunistic standpoint we observe a sharp break. Well toward the top of the series, in the Titanothere quarry . . . worked by the Carnegie Museum during 1929–30, we have secured an abundance of material pertaining to a typical Oligocene form (*Teleodus*). In the same quarry were found the portion of a lower jaw of a Cameloid (Poëbrotherium) and remains of Hyaenodonts. With these was also discovered material representing a small rhinoceros provisionally referred to *Amynodon* and a fragment of a mandibular ramus, with M_2 in place, of a mesonychid comparable in size with *Mesonyx* [i. e. *Pachyaena*] *ossifragus*. Outside of the two latter genera the fauna, so far found in this new quarry, is certainly representative of a post-Eocene or basal Oligocene deposit.

. . . According to the faunistic evidence now in our possession we must regard the uppermost red series of the

Uinta sediments as pertaining to the basal Oligocene, which has been more or less anticipated, though not hitherto proven, by paleontologists who have visited and worked in the Tertiary sediments of the Uinta Basin.

The lower members of the Uinta sediments are apparently entirely absent along the northern border of the Uinta Basin. Horizons A, B, and C_1 (= C_1 of Osborn) so characteristic of the southern and middle part of the Uinta Basin, together with the rich fauna of horizons B and C, are entirely lacking along the northern borders. This apparent unconformity, observed by Peterson in the years 1893–1912, by Douglass in 1908–09, by Kay 1928–29, led to the fruitless search by these parties for a distinct break between the Upper and Lower Uinta sediments along the southern, or rather the middle exposures, in the Uinta Basin.[1]

In a later paper by Peterson,[2] the uppermost beds of the Uinta Basin were formally separated from the Uinta Eocene and erected into a distinct stage, a proposal which has been generally accepted.

It is quite clear that the name "Upper Uinta," which was used by Peterson and Kay in their publication, Ann. C. M., Vol. XX, pp. 293–305, might in the future be a source of confusion to students. The "Upper Uinta" is a term which was and will be commonly used by geologists and palaeontologists in referring to the upper series of the Uinta Eocene, especially "Horizon C." The name "Duchesne," . . . is therefore proposed for the Oligocene horizon, which rests upon the Upper Eocene (Horizon C) in the Uinta Basin. The Duchesne River in Duchesne County, Utah, has its source on the southern side of the Uinta Mountains. The stream traverses these upper beds, which are now determined to be Basal Oligocene, before its confluence with the Green River a half mile below Ouray, Utah. . . . The geographical area covered by these Oligocene strata has an east-west extent of approximately eighty miles, and seldom exceeds from twelve to fifteen miles in a north-south direction along the northern margin of the Uinta Basin. From Randlette westward, along the Duchesne river, these Oligocene beds are quite clearly defined from the underlying Uinta series (Horizon C). . . . The sandstones weather out to characteristic reddish brown cliffs, which rest on softer clays [Horizon C of the Uinta] along the streams and on the divides between Lake Fork, "Dry Gulch," Duchesne, and the course of other rivers. Although a tentative division was made by Peterson and Kay between the Duchesne beds and the underlying Uinta strata to the eastward from Randlette, the distinction between the two horizons is not so clear toward the eastern end of the basin.

The relationship of the fauna of the Duchesne Oligocene, as now known, is less sharply defined from that in the underlying Uinta sediments (Horizon C) than is usually the case in the superimposed horizons of other localities. There is, nevertheless, an advance corresponding to that of the lithological change noted. The Titanotheres of the Duchesne Oligocene so far known represent an advance upon those found in Horizon C of the Uinta series. *Teleodus uintensis* is a typical Oligocene form, with frontonasal horns well developed; with two upper and three lower incisors, bearing the characteristic button-shaped crowns found in all the known Titanotheres of the White River Oligocene. The horses, or Anchitheres, and Tapiroids have the lower premolars more like the molars. The Cameloids are very distinctly advanced in the direction of those found in the White River Oligocene. The genus *Hyænodon* of the eastern Oligocene, not heretofore found in the Eocene of America, is recognized. With this assembly of forms there are, so far found, remains of Anchitheres, Amynodonts, Homacodonts, Agrichœrids, and Mesonychids, as survivors from the underlying Eocene. The Amynodonts have the second lower premolar reduced to vestigial proportions. The Homacodonts and Mesonychids have advanced in their trend of evolution. It is quite safe to say, that, when more complete material is found representing the Agrichœrids and the Oreodonts, they will be found to have similarly advanced.

The Duchesne Oligocene of the Uinta Basin may thus be regarded as a horizon quite perfectly transitional between the Upper Eocene and the Chadron horizon of the White River series of South Dakota. We were gratified in finding in the Duchesne Oligocene the genus *Hyænodon*, hitherto not reported from so low a level in the American Oligocene. In this vast deposit of strata, over one thousand feet thick, we have not yet discovered any horizons which abruptly traverse the formation, such as the well known Metamynodon and Protoceras Sandstones; the two latter being stream deposits, which contain sudden breaks in the Oligocene fauna of the White River Badlands of South Dakota. The evidence of stream action is abundant in the Duchesne series, but the scarcity of fossil remains through the entire formation precludes at this time any clear comparison with what is known of the Oligocene of Dakota.

Of the fossils described in the following pages the fragment of an upper jaw as well as limb bones of *Hyænodon* were found in 1929 in the Titanothere quarry of the upper Duchesne Oligocene and the fragment of a lower jaw of the Amynodont described in the following pages was found in the same quarry in 1930. The rest of the material described in what follows was collected in different horizons of the Oligocene of the Uinta Basin.[3]

Much the most complete study of the stratigraphy of the Uinta Basin that has yet been published is a paper by Mr. J. Leroy Kay, of the Carnegie Museum, entitled "The Tertiary Formations of the Uinta Basin, Utah." The part of this paper which deals with the Duchesne River beds may be quoted, in somewhat abbreviated form, with advantage.

DUCHESNE RIVER (OLIGOCENE) FORMATION

The name "Duchesne" was proposed by Professor W. B. Scott for the Lower Oligocene Formation of the Uinta Basin, Utah. . . . Duchesne has been used in several publications by the Carnegie Museum. It appears that the name Duchesne is preoccupied, having been used by Keyes [4] for a limestone of Jurassic age. This duplication is rather unfortunate. A new name is required for the Oligocene formation in Utah, but the writer feels that there will be less confusion if the word "Duchesne" is retained in the new term. At Prof. Scott's suggestion the name **Duchesne River** is now proposed for the lower Oligocene formation of the Uinta Basin, Utah.

The Duchesne River Formation to the south lies conformably upon Horizon C of the Uinta Eocene, but with greater or less unconformity with the older rocks along its northern border. It is composed chiefly of alternating bands of sandstones and red, brown, and variegated clays, the sandstones often enclosing lenses of arenaceous clays.

[1] Peterson, O. A., and Kay, J. L., *Ann. Carnegie Mus.* **20**: 293–306, 1931.

[2] Peterson, O. A., *ibid.* **21**: 61–78, 1932.

[3] *Ibid.* **23**: 357–371, 1934.

[4] Keyes, C. R., Grand Staircase of Utah, *Pan. Amer. Geologist* **41**: 36, Feb. 1925.

Many of the clay members are deceptive as to their thickness. In weathering out they cover the sandstones below and appear to be several feet in thickness but if the surface is cleaned off, they are found to be only a few inches thick. The surfaces of the sandstones are more or less stained by these clays and appear to be reddish-brown in color, but are mostly grey or very light brown. In looking at the beds as a whole, they appear a brick red. The sandstones predominate and are often conglomeratic.

At Rock Creek, where the cross-section of the western part of the Uinta Basin was made, the Duchesne River Formation has a thickness of over fifteen hundred feet, which is probably the maximum thickness. The greatest north-south extent of this formation is east of Lake Fork.

In most places along the northern border, at or near the base of the Duchesne River sediments, heavy bedded, coarse conglomerates occur. These conglomerates probably attain their greatest thickness at Currant Creek but are well exposed at Lake Fork where they rest with a slight southern dip upon the Triassic and Jurassic. The latter formations at this point have a dip of about sixty degrees. . . .

In the Asphalt Ridge, about five miles south and west of Vernal, . . . specimens were found and identified by O. A. Peterson as lower Oligocene Agriochœrids. . . . Thus it appears that these conglomerates cannot always be considered the base of the Duchesne River Formation.

Along the northern border, the contact of the Duchesne River with the older rocks is more or less obscured by reworked glacial gravels which cap most of the benches and only in a few places are they consolidated. In several places, lying beneath the Duchesne River Formation, are exposed strata of undoubtedly Eocene age. Although these beds were prospected no identifiable fossils were found. The best exposures are between Rock Creek and the Duchesne River; Lupton[5] maps them as Wasatch. The writer is inclined to regard them as Uinta. This conclusion is based chiefly on their lithological character.

To facilitate correlation and reference of specimens now in the Carnegie Museum, the Duchesne River Formation is divided into three horizons. These are, from lowest to highest, the **Randlett**, the **Halfway**, and the **Lapoint**. The type locality for the Randlett Horizon . . . is north and east of the town of that name and consists of 478½ feet of brown, red, bluish grey and variegated clays alternating with brown and grey sandstones. These beds are capped by a ten foot stratum of conglomerate . . . which is taken as the base of the Halfway Horizon.

The strata of the Halfway Horizon are well exposed along Halfway Hollow, the basin which drains that district. . . . There are 557½ feet of sediments referred to this horizon, consisting chiefly of sandstones and shales with several conglomerate members. The sandstones in general are coarser than those of the Randlett. Overlying the Halfway is a layer, twenty-two feet thick, of bluish white clay . . . , which can be seen just north of the Vernal-Lapoint Road and is quite persistent throughout the area. This is considered the basal member of the Lapoint.

The Lapoint, the uppermost division of the Duchesne River Formation, is typically observed along the head of Halfway Hollow east and north of the town of Lapoint. This horizon includes 336 feet of sandstones, clays, and conglomerates. The conglomerates are coarse, the sandstones conglomeratic, and the shales quite sandy.

Much of the so-called "Uinta" of Beaver Divide, in central Wyoming, should, in my opinion, be included in the Duchesne River, at least provisionally. The exposures were first described by Granger, whose account may be here summarized.

> The divide rises to a height above Beaver Creek of over 1,200 feet. . . . To the southward the land slopes gently down to the Sweetwater; to the northward, facing the Wind River Basin, it breaks off very abruptly [and precipitously] . . . along almost the whole southern border of the basin. . . . The beds of this bluff in the area examined, aggregating nearly 1,100 feet, are all Tertiary, lying nearly horizontal, and resting on the upturned edges of the Mesozoic strata. . . .
>
> Lithologically, as well as faunally, the beds fall into three groups: (1) the red banded clays and coarse sands of the Lower Eocene, (2) the greenish, blue-gray and olive-colored shales . . . of the (?) Middle and Upper Eocene, and (3) the buff and light gray calcareous marls of the Lower Oligocene. The upper and lower groups are fairly constant in character throughout the area examined, but the middle one is variable, the various strata maintaining their character over a very limited area only. An exception to the uniformity of the Lower Oligocene is the presence, near Wagon-bed Spring, of a five-foot bed of volcanic material not observed at Green Cove, where the above section was taken [fig. 1, p. 238]. The bed is from fifty to one hundred feet above the unconformity and consists of gray ash, in which is [*sic*] imbedded in places numerous smooth, rounded masses of pumice an inch or two in diameter. . . .
>
> No break in sedimentation was detected in the Eocene series, yet a careful examination by a competent stratigrapher might bring it to light. The Bridger formation in the Bridger Basin has a maximum thickness of 1,800 feet, and the only beds in this section which might be assigned to that formation are the 200 or 250 feet of unfossiliferous strata between the Lower Eocene banded beds and the layers lying immediately below the unconformity, which are unquestionably Upper Eocene.

It must be remembered that, when Granger wrote this description, the existence of the Duchesne River, as a separate unit, had not been suspected and the uppermost beds of the Uinta Basin were unhesitatingly referred to the Uinta stage. He continues:

> Mammalian fossils were found on three levels, as noted in the section above. They were not at all abundant at any level nor in any locality, and it was only by painstaking and prolonged search that the number of forms listed below was obtained. . . .
>
> On the Uinta level the fossils came, with one exception, from Wagon-bed Spring, and were found mostly in a pale yellowish, tough, sandy clay. . . .
>
> It is doubtful, therefore, whether this horizon is to be correlated with the true Uinta (Horizon C) or with Uinta B and its equivalent (in part) of the Washakie Basin, Washakie B.[6]

Granger regarded the disconformity, which is clearly shown in his generalized section of the Tertiary at Beaver Divide, as the boundary between Eocene and Oligocene, but Dr. John Clark, who has examined the section and who referred the beds just below the break to the Uinta, not the Duchesne River, writes me (*in litt.*) as follows: The Uinta

[5] Lupton, Charles T., The Deep Creek District of the Vernal Coal Field, Uinta County, Utah, *U. S. Geol. Surv. Bull.* **471**: 579–594, 1912.

[6] Granger, W., *Bull. Amer. Mus. Nat. Hist.* **28**: 237–241, 1910.

is overlain by a series of tan and white agglomerates and tuffs, from the lower part of which [Granger] collected Chadron titanotheres. At this point there is some confusion, since the Carnegie Museum recently collected a skull of *Protoreodon* from one of the agglomerates. Naturally enough, Granger placed the boundary between the Uinta and the Chadron at the base of the agglomerates; occurrence of so definitely Eocene a form as *Protoreodon* within the agglomerates demonstrates that the contact lies higher, somewhere within the agglomerate series, and has not yet been accurately determined.

While not accepting Clark's dictum that the presence of *Protoreodon* demonstrates the Eocene age of the containing beds, we may admit that the exact boundary between the White River and the older formation remains to be determined.

Professor H. E. Wood, who has also examined the Beaver Divide section, reports that the *Amynodon* skull, the discovery of which was hailed with such interest, is definitely referable to the Uinta species, *A. advenus*, and that it lay below the levels at which the supposedly Duchesne River fossils were found, *Brachyhyops*, *Protoreodon*, and *Mesagriochoerus*. He agrees with me in thinking that in the Beaver Divide section are to be found at least three stages above the Wind River Eocene. In descending order these are: (1) the Chadron substage of the White River; (2) Duchesne River; (3) Uinta. Beneath the Uinta lie 185 feet of completely barren sandstones, in which no fossils have ever been found. These, Granger tentatively referred to the Bridger, or Middle Eocene, but they may equally well be assigned to the Uinta. As Granger noted, there is no perceptible stratigraphic break between the Wind River below and the topmost Uinta above, and there must be two, or more, hiatuses in time in these beds, which are only 540 feet thick and yet represent the entire Middle and Upper Eocene and part of the Lower. In the Bridger Basin of southwest Wyoming the Bridger formation alone measures 1800 feet in thickness, to say nothing of the thick masses of Wind River and Gray Bull in the Bighorn Basin.

DUCHESNE RIVER FAUNA

The subjoined list is taken, with some additions and corrections, from the posthumous paper by Peterson,[7] his last contribution to a subject which he had made so peculiarly his own.

REPTILIA

TESTUDINATA

Cymatholcus longus Clark

CROCODILIA

Crocodilus? acer Cope

MAMMALIA

INSECTIVORA

LEPTICTIDAE

Protictops alticuspidens Peterson

CARNIVORA

CREODONTA

MESONYCHIDAE

Hessolestes ultimus Peterson

HYAENODONTIDAE

Hyaenodon sp.

FISSIPEDIA

UINTACYONIDAE

?Pleurocyon, or *?Uintacyon* sp.

?FELIDAE

Eosictis avinoffi gen. et sp. nov.

RODENTIA

PARAMYIDAE

Leptotomus kayi Burke

ADJIDAUMIDAE

Protadjidaumo typus Burke

LAGOMORPHA

LEPORIDAE

Mytonolagus sp. Peterson

ARTIODACTYLA

PALAEODONTA

HELOHYIDAE

?Helohyus sp.

DICHOBUNIDAE

Pentacemylus progressus Peterson

?CHOEROPOTAMIDAE

Brachyhyops wyomingensis Colbert

TYLOPODA

AGRIOCHOERIDAE

Mesagriochoerus primus Peterson
Diplobunops crassus sp. nov.

MERYCOIDODONTIDAE

Protoredon tardus sp. nov.

HYPERTRAGULIDAE

?Leptomeryx minutus Peterson

CAMELIDAE

Camelodon arapahovius Granger
Poabromylus kayi Peterson

PERISSODACTYLA

EQUIDAE

Epihippus (*Duchesnehippus*) *intermedius* Peterson

BRONTOTHERIIDAE

Teleodus uintensis Peterson
Protitanotherium sp.

---

[7] Peterson, O. A., *op. cit.* **23**: 373, 1934.

HELALETIDAE

Heteraletes leotanus Peterson

HYRACODONTIDAE

Hyracodon primus Peterson

Mesamynodon medius Peterson

AMYNODONTIDAE

Megalamynodon regalis gen. et sp. nov. H. E. Wood

?RHINOCEROTIDAE

Epitriplopus medius Peterson

?CHALICOTHERIIDAE

?Chalicothere sp.

In spite of the extreme scarcity of its fossils, the Duchesne River fauna is decidedly a rich one, in the sense of the number of families and genera represented. There are two reptilian orders, and of mammals there are already known 6 orders, 22 families, and 26 genera. It will be observed that, with two exceptions, each family is represented by a single genus and each genus, again with one probable exception, has but one species. These numerical relations are strongly indicative of a fragmentary fauna, which is very incompletely known.

As to the Duchesne River reptiles, the fossils are even more scanty than those of mammals, but there is one point in connection with them, which is of some interest. The crocodile skull which Peterson provisionally referred to *C. acer* Cope, is one of the larger Eocene types, the specimen having an approximate length of 16–18 inches. After this time, crocodilians became very rare in the northern United States, and the large true crocodiles, which were abundant in the Eocene, were replaced by a dwarf species of alligator in the Chadron substage of the White River. Climatic change was almost certainly not the occasion of this revolution, which was more probably due to increased altitude of the Rocky Mountain region than to any general change of the North American climate.

Attention has been repeatedly called to the apparent conformity between the Duchesne River beds and the underlying Myton substage of the true Uinta; Peterson and Kay even expressed a provisional belief in the continuous deposition of all the Tertiary sediments, including those of the Duchesne River, of the Uinta Basin.[8] However, two considerations show that this apparent conformity is deceptive: (1) the overlapping of the Duchesne River beds upon Triassic and Jurassic along the northern border and (2) the sudden and almost complete break between the fossils of the topmost Uinta (Myton substage = Horizon C) and those of the Duchesne River implies a considerable hiatus in time. Very probably, this hiatus was greater than the faunal lists, *as at present constructed*, would lead one to believe, for, so fragmentary is much of the material, that specific or even generic determination of it is impracticable. Of the clearly determinable species, none is common to Horizon C of the Uinta and the Duchesne River, and only those of the genera *Epihippus*, *Diplobunops*, and *Protoreodon* are known in the Uinta. The lapse of time between the Myton and the Duchesne River may not be so great as that between the last-named and the Chadron, but the difference is not very marked. The faunal change is abrupt, as appears from the absence of a single definable Uinta species from the Duchesne River beds, and even the common genera are somewhat doubtful, except in the case of *Diplobunops*, of which a new and very distinct species is described in the following pages. Even the horselike genus *Epihippus*, Peterson believed, would, when more completely known, prove to be distinct from the Uinta genus, and, for this eventuality, he proposed the hypothetical term *Duchesnehippus;* the agriochoerid, *Diplobunops*, quite certainly survived from the upper Uinta. *Protoreodon* appears to be another survival, but is somewhat questionable and may, eventually, be assigned to a different genus; the species *P. tardus*, again, is very distinct and appreciably nearer to the White River *Merycoidodon*.

Because of the extreme scarcity of its fossils, but few palaeontologists have had an opportunity to study the Duchesne River fauna, but all of them have, "with one accord," emphasized its transitional character between the latest Eocene and the earliest Oligocene, as previously known, the Chadron of South Dakota and adjoining states. When the Duchesne River fauna is considered as a whole, this transitional character is very obvious. Several of the genera are clearly more or less modified survivals from the Uinta, others are new and akin to, or even congeneric with White River forms, such as *Teleodus*, *Hyracodon*, and *Hyaenodon*, seemingly their first appearance in North America. A very interesting possibility is suggested by the genus which I am proposing to name *Eosictis* and regard as the most ancient of American sabretooths. The type specimen is too incomplete to demonstrate that this animal was a fissiped and not a creodont; it might even prove, when more completely known, to be related to the remarkable sabretooth creodont, *Apataelurus*, of the Uinta. I believe, however, that it is more probably a machairodont. Several genera of this fauna, such as *Hessolestes*, the latest known member of the creodont family, Mesonychidae, and *Diplobunops*, of the Agriochoeridae, appear to have died out, leaving no descendants.

The individual genera illustrate, even better, the transitional nature of the fauna; *Teleodus*, a brontothere, is transitional between the Uinta members of the family, such as *Diplacodon* and *Protitanotherium*, and the White River forms, though such is the welter of variations in the Chadron brontotheres, that it is impossible to select the actual descendants of *Teleodus*, especially as migration from Eastern Asia probably played an important, though as yet an indeterminable, part in recruiting the White River brontotheres.

[8] Peterson, O. A., and Kay, J. L., *ibid.* **20**: 295, 1931.

All of the three families of the Rhinocerotoidea, the Hyracodontidae, the Amynodontidae, and the Rhinocerotidae, appear to be represented in the Duchesne River fauna, though remains are insufficient for a generic determination in all of them. Peterson assigned certain fossils to the White River genus *Hyracodon*, and I have followed his example. The amynodonts, on the other hand, are admirably represented by the genus which H. E. Wood, in subsequent pages, proposes to name *Megalamynodon*. This is an ideally perfect transition between the ancestral *Amynodon*, of the Uinta, and the White River descendant, *Metamynodon*. There can be little doubt that the true rhinoceroses, of the family Rhinocerotidae, were represented in the Duchesne River fauna, as they almost certainly were in the antecedent Uinta and unquestionably were in the subsequent Chadron.

Of the horses, very few remains have been collected, the best of which is a right *ramus mandibuli*. This, Peterson felt assured, would eventually prove to be referable to a new genus, intermediate between the Uinta *Epiphippus* and *Mesohippus*, of the White River.

The aberrant, clawed Perissodactyla, which Cope named the Ancylopoda, are listed by Peterson, though only as a questionable chalicothere, but we may be sure of their presence in the fauna, for they occur in the preceding upper and middle Eocene and in the succeeding Oligocene and Miocene.

Artiodactyla are less common in the fauna than would have been expected, though six families, at least, are represented, most of them by a single genus each. A small bunodont was tentatively referred by Peterson to the Bridger genus *?Helohyus*, but the reference is not likely to be confirmed by future discovery, because of the long hiatus in time. *Helohyus* has never been found in the Uinta. *Pentacemylus* may well be referable to the European family of the Dichobunidae, in which Sinclair has included most of the Bridger artiodactyls, but the material is insufficient to make the reference certain.

Another questionable bunodont artiodactyl is the relatively large *Brachyhyops*, which was found at the Beaver Divide, Wyoming, and is, therefore, but tentatively included in the Duchesne River fauna. Colbert[9] has referred this strange creature to the European family, Choeropotamidae, of which it will be one of the very few American representatives, if the reference is confirmed. Stratigraphically, it is without assignable significance, for it stands alone.

The Camelidae are one of the rare families which are represented in this fauna by more than one genus; that is, on the assumption that the Beaver Divide fossils are properly referable to the Duchesne River. Both of these genera, *Camelodon* Granger, from the Beaver Divide, and *Poabromylus* Peterson, from the Uinta Basin, might well have been derived from the Uinta *Protylopus*, though only Peterson's genus can be regarded as transitional to the White River *Poëbrotherium*.

Of the two Oreodont families, only the Agriochoeridae have, as yet, been found in the Duchesne River of Utah, and this is another of the exceptional families with more than one genus in these beds. One of these genera, *Diplobunops*, is a survival from the Uinta and, so far as is known, the species, *D. crassus*, is peculiar and is the last of the series, which appears not to have extended into the White River. The true agriochoerids are represented by *Mesagriochoerus*, which is a most interesting and significant transition between the Uinta and the White River forms. *M. primus* Peterson is the only mammal which has, as yet, been found in both the Utah and the Wyoming areas.

The merycoidodonts have not been found in the Duchesne River beds of Utah, a lack which is, assuredly, merely an accident of collecting. In the Wyoming area of Beaver Divide a peculiar species of the Uinta genus *Protoreodon* has been obtained in strata above the disconformity which has been supposed to mark the lower boundary of the White River.

Attention has been called to the remarkable thickness of the Duchesne River beds, 1,500 feet, which is four or five times as great as the entire section of the White River, as exposed in the "Big Bad Lands" of South Dakota. In the latter there are three very distinct faunal zones, the *Brontotherium*, *Merycoidodon*, and *Protoceras-Leptauchenia* beds, corresponding to the stratigraphic divisions of the Chadron, Lower and Upper Brulé, respectively, and, within the limits of these substages, all of the families of mammals show marked evolutionary changes, so that hardly a single genus occurs in all three of the substages. There can be no reasonable doubt that, were the Duchesne River fossils at all comparable in numbers and variety with those of the White River, a similar development might be observed through consecutive strata. It is true that Kay was able to distinguish three substages, the Randlett, the Halfway, and the Leota, but he made these divisions on lithological grounds. In the excessive rarity of the fossils, it is quite impossible to distinguish faunal zones. The fossils collected near the bottom of the Randlett are entirely different from those found near the top of the Leota, but the meaning of this difference it is wellnigh impossible to interpret, for one cannot say how far it is accidental and due to the hazards of collecting and how far it is inherent in the stratigraphical succession. However, the list, incomplete as it is, does give a fair conception of the fauna and suffices to fix its position in the geological column. I am entirely in agreement with those members of the Carnegie Museum staff, Messrs. Peterson, Kay, and Clark, who have been most concerned in the collection and preparation of the Duchesne River fossils, in their determination of this fauna as the oldest known Oligocene. That it is intermediate in

[9] Colbert, E. H., *Ann. Carnegie Mus.* **27**: 87–108, 1938.

time between the uppermost Uinta Eocene (C, or Myton) and the oldest White River (Chadron substage) is obvious. The only question that can arise in this connection is: Where should the line between Eocene and Oligocene be drawn? There is an almost complete continuum between Wind-River—Bridger—Washakie—Uinta—Duchesne-River—Chadron, and in this great thickness of beds there is hardly any stratigraphic break, except those made by geographical separation, e. g. between the Wind River and Bridger, and, perhaps, between the Bridger and Washakie, though Clark does regard the lower Washakie as equivalent to the topmost Bridger.

It is a generally accepted principle that, in dealing with stratigraphic problems, greater weight should be given to forms which are newcomers than to persistent older forms. The Duchesne River fauna includes several species which are referred to White River genera, such as *Hyaenodon*, *Hyracodon*, *Teleodus*, and several genera which, appearing for the first time, are clearly intermediate between Uinta and White River forms and are more advanced than the former, less so than the latter. Examples of this kind are *Mesagriochoenus*, *Poabromylus*, and *Megalamynodon*, which have an obviously intermediate position between the Uinta and the Chadron forms. The new genus, *Eosictis*, is, unfortunately, represented by a very incomplete type specimen, but is very probably a machairodont and, if so, is the first appearance of the group in North America and emphasizes the Oligocene reference.

Equally significant is the fact that the genera which survive from the upper Uinta are all represented by new species, and almost all persistent ancient families by new genera. It is probable that, if better preserved material were available, nearly all the genera which are now listed under Uinta names would prove to be so different as to require new terms.

To Peterson's list of Duchesne River mammals, I have added those found at the Beaver Divide in Fremont County, Wyoming. The list of these fossils is so very short, that correlation of the beds is uncertain, further than to say that they are referable either to the Duchesne River or to the uppermost Uinta. In the lower strata of the section occurs the typical Uinta species *Amynodon advenus;* above these strata and succeeding them conformably are beds that have yielded fossils which are distinctly more advanced than those of the Myton substage (Uinta C), such as a large species of *Protoreodon*, one of *Mesagriochoerus*, and the extraordinary skull which Colbert has named *Brachyhyops* and referred to the European family Choeropotamidae. The presumably Duchesne River beds are unconformably overlain by unmistakable Chadron.

The Sespé formation of southern California offers an instructive parallel to the succession of beds at Beaver Divide, Wyoming. The 7,000 feet of continental deposits, which make up the Sespé, appear to represent the whole of Oligocene time and to include some of the Upper Eocene. They rest unconformably upon marine Eocene and are unconformably overlain by marine Miocene. Most of the great thickness of the Sespé is barren of fossils, but a considerable fauna of mammals occurs at a level about 1,500 feet above the base of the deposits, and this fauna has much resemblance to that of the Duchesne River formation. Professor Chester Stock, of the California Institute of Technology, prefers to regard the fauna as latest Eocene, but, as already stated, I feel compelled to agree with the palaeontologists of the Carnegie Museum in assigning the Duchesne River and, with it, the lower Sespé, to the Oligocene. The fossils of the beds at Beaver Divide upon which the White River rests, though very few, probably suffice to show that these beds are intermediate in time between the Myton (Uinta C) and the Chadron, as is indicated by their stratigraphic position.

The continental Lower Eocene of North America has a mammalian fauna which contains a great many elements in common with that of Europe and Asia, a feature which is usually explained by postulating a land connection between Kamchatka and Alaska, across what is now the shallow Bering Sea. This connection, which is extremely probable, must have been severed or, at least, greatly restricted, in the Middle Eocene, for the Bridger and Washakie mammals differ more from their Old World contemporaries than was the case in any other part of Tertiary time. Again, in the Uinta, there was a great influx of selenodont artiodactyls, evidently immigrants from some other region, and this very probably points to a renewal of the land bridge to Asia, which, apparently, was not again interrupted until after the close of the Pleistocene.

The intermediate, transitional nature of the Duchesne River fauna has been repeatedly emphasized, and this characteristic is not likely to be changed by future discoveries, however much the list of genera may be increased.

Order **INSECTIVORA** Latreille

Small mammals are particularly rare in the Duchesne River beds; one insectivore, one lagomorph, and two rodents are all that the collectors have, so far, obtained.

Family **LEPTICTIDAE** Gill

This characteristically North American family is most abundant and varied in the White River, beyond which it is not known to extend; it is also frequent in the Bridger and the Uinta.

PROTICTOPS Peterson

Protictops Peterson, *Ann. Carnegie Mus.* **23**: 374, 1934.

Protictops alticuspidens Peterson

Protictops alticuspidens Peterson, *loc. cit.*

As I have nothing to add to Peterson's description (pp. 374–375), I reproduce it here.

Principal characters of the holotype. Trigonid relatively large and the heel small when compared with the molars of *Ictops acutidens* Douglass. The paraconid is larger and of greater functional value when compared with the latter species. In the present form, the heel of the molar is of a more nearly cross-crest structure but with the median region constricted and the median tubercle very indistinct or not at all indicated, while in *Ictops acutidens* the median tubercle is well formed. The specimen pertains to an animal approximately one-half the size of *Ictops acutidens.*

An upper premolar (?P^3) found in the same horizon and locality in which *Protictops* was found, is associated with this series of specimens and referred to the Insectivora. It is rather doubtful that the specimen pertains to the genus proposed above, because the posterior part of the prominent protocons is more nearly of a carnassial structure and has no true tritocone as in *Ictops.* There is, however, an antero-external basal tubercle as in P^3 of *Ictops.* The deuterocone is definitely formed, but basal in position and the crown is surrounded by prominent external, internal and posterior cingula.

Peterson gives no measurements, but his figure indicates that the antero-posterior diameter of m_1 and m_2, taken together, is 4.5 mm.

Order **CARNIVORA** Gray

Even in the scanty list of the Duchesne River, the rarity of predaceous mammals is noteworthy; both individually and specifically, beasts of prey are very uncommon, though two families of creodonts and two of fissipeds have been found. All the fossils of these groups, so far discovered, are in a very fragmentary state, and the generic identification of them is more or less uncertain.

Suborder **CREODONTA** Cope

Two families of creodonts are, almost certainly, represented in this fauna, one, the very ancient Mesonychidae, in what is believed to be its latest appearance; the other was identified by Peterson as the White River *Hyaenodon.*

Family **MESONYCHIDAE** Cope

This family is one of the oldest of all the creodonts and extends from the Paleocene through the entire Eocene into the lowest Oligocene. The Eocene genera are remarkably specialized for cursorial habits and have tetradactyl feet of paraxonic symmetry; the ungual phalanges are broad and almost hooflike, whence the name of the typical genus, the Middle Eocene *Mesonyx,* of the family. Each division of the Eocene had one or more characteristic genera. The dentition is a curious combination of primitive and specialized features; the upper molars are tritubercular of very primitive pattern, while the lower are reduced to two cusps of pseudo-sectorial shape. The Duchesne River genus *Hessolestes* Peterson is, so far as is yet known, the last representative of the family.

HESSOLESTES Peterson

Hessolestes Peterson, *Ann. Carnegie Mus.* **20**: 338, 1931.

The typical and only known specimen of this genus is a fragment of the right *ramus mandibuli* from the hinder end of the jaw, comprising the angle, condyle, coronoid, and part of the dentary portion, m_2 in place and the alveolus of m_3. This suffices to confirm Peterson's reference of the fossil to the Mesonychidae and also to demonstrate its generic distinction. The original definition is:

> M_3 rudimentary; M_2 with posterior basal heel more symmetrically rounded, a mere trace of the anterior basal cusp, the tooth relatively larger, the angle shorter and deeper than in *Harpagolestes.*
>
> The fragment upon which this genus is based furnishes characters which at once distinguish it from *Harpagolestes* found in the middle and upper Eocene. It seems quite evident that M_1 and M_2 have increased in size and otherwise changed, while M_3 has decreased to vestigial proportions being inserted in the jaw with probably only a single root.

Hessolestes ultimus Peterson

Hessolestes ultimus Peterson, *Ann. Carnegie Mus.* **20**: 338, 1931.

Peterson's figures do not altogether agree with his description. Figure 1, the side view of m_2, shows a complete tooth, with uninterrupted cingulum and anterior basal cusp reduced to "vestigial proportions," while figure 2, the crown view, shows that the front end of the tooth was broken away; the plane of fracture, as may be seen from the specimen itself, passing down through the anterior root. Evidently, the anterior basal tubercle was larger than Peterson supposed, and it may have been relatively as well developed as in *Harpagolestes;* the posterior cusp is an imperfectly shearing blade and is much smaller than the anterior cusp, or protoconid. In the preceding genera of the family, the lower molars are bicuspid, having lost the inner elements, while the two external cusps are of subequal size and are in the same fore-and-aft line, the two together forming a rather blunt shearing blade, but in *Hessolestes,* alone in the genera of the family, the reduction of the metaconid gives to m_2 a peculiar appearance. Peterson was assuredly right in inferring from the single, matrix-filled alveolus that m_3 was much more reduced than in the antecedent genera of the family and was a mere vestige.

The fossil is the posterior part of the right half of the lower jaw, of which the ascending ramus is preserved almost entire and the external side is covered with matrix. The lingual side is smooth, featureless, and nearly plane, except that the angle is slightly concave. This portion of the jaw displays many small differences from that of *Harpagolestes,* though the two are manifestly of the same family type. The following points of difference between the two genera should be noted.

In *Hessolestes:* (1) The anterior border of the coro-

noid is much less steeply inclined, and the whole ascending ramus is relatively wider; the posterior border is more nearly erect.

(2) The sigmoid notch is broader, shallower, and much less distinctly marked.

(3) The position of the condyle is remarkably low, far beneath the level of the molars, and relatively much lower than in any other known genus of the family. Compared with that of the machairodont subfamily of the Felidae, the mandibular condyle of *Hessolestes* has a more inferior position than in any but such extremely modified forms as *Eusmilus*. In the absence of the canines, it is impossible to make sure of the significance of this position of the condyle, but it certainly suggests that the upper tusks were laniary sabres. If so, the genus must be related to the extraordinary Uinta sabretooth creodont, *Apataelurus kayi*, which belongs either to the Oxyaenidae or to the Hyaenodontidae. As long as the dentition remains so incompletely known, the systematic position of *Hessolestes* must remain indeterminate and the genus may be left in the Mesonychidae, where Peterson placed it.

(4) The condyle projects much farther behind the coronoid, but is less upturned.

(5) The angle extends much farther below (ventrally) the condyles and, presumably, projected downward as a distinct process, set off from the horizontal ramus; there is not the least indication of an inflection of the angle.

MEASUREMENTS

Distance from m_3 to summit of coronoid	71 mm.
Ascending ramus, height from coronoid to angle	112
M_3, antero-posterior diameter (est.)	25
M_3, transverse diameter	11

Horizon: Lapoint substage of Duchesne River
Locality: 11 miles W. of Vernal, Utah

FAMILY **HYAENODONTIDAE** LEIDY

The American history of this family begins in the Lower Eocene with certain small, lightly built, long-tailed creatures, the classification of which is made according to the dentition; these genera continued through the Bridger, but have not been found in the Uinta, and, apparently at least, the family died out in North America with the end of the Bridger. In the White River large representatives of the family have long been known, and that they were immigrants from Asia has been generally agreed, especially as the type genus, *Hyaenodon*, is European.

The discovery of *Hyaenodon*, by the Carnegie Museum collectors, in the Duchesne River beds was of great interest, as marking the earliest known appearance in America of this typically European genus. Though the material is very scanty, it suffices for a probable identification. Another European genus of this family, *Pterodon*, occurs in the Sespé of California.

HYAENODON LAIZER ET PARIEU

Hyaenodon Peterson, *Ann. Carnegie Mus.* **21**: 64, 1931.

The original description is as follows:

A portion of the maxillary of the right side, with the last two molars in place . . ., is referred to the well known genus *Hyænodon* of the Nebraska and Dakota Oligocene. The specimens were found in the Duchesne Oligocene together with the great mass of material representing *Teleodus uintensis* in the Titanothere Quarry eleven miles west of Vernal. The maxillary represents an animal smaller than *Hyænodon cruentus*, but larger than *Hyænodon crucians*. With the exception of a well-marked swelling on the external face of the shearing blade, midway between the anterior cusp and the posterior limit of the last tooth, the detailed structure of these most closely suggests those of *Hyænodon cruentus*. On the last tooth there is no indication of an antero-internal basal tubercle, while on the tooth in front there is a very slight indication of such a tubercle. The maxilla is broken off at the posterior alveolus of the larger tooth and in front of the first molar.

To this description, it may be added that each of the molars is implanted by three roots, two anterior and one posterior, and that the anterior half of the crown is more than twice as broad transversely as the posterior part. Both teeth are much more abraded on the lingual side, so that any antero-internal cusps which may have originally been present, have been worn away. On m^1 the lingual face has lost all its enamel, but on m^3 only the anterior cusp is so worn; on the hinder shearing blade the enamel is almost intact.

Hyaenodon *sp.* Peterson

Hyaenodon sp. (?) Peterson, *Ann. Carnegie Mus.* **21**: 64, 1932.

Despite its great interest and stratigraphic importance, Peterson did not propose a species name for this fossil, and his example is here followed.

In the subjoined table the dimensions given by Peterson have been verified and, where necessary, corrected, and one or two others have been added.

MEASUREMENTS

M^1, antero-posterior diameter, on base	12 mm.
M^1, transverse diameter, anterior face	7
M^1, transverse diameter, posterior face	4
M^2, antero-posterior diameter, on base	17
M^2, transverse diameter, anterior face	9
M^2, transverse diameter, posterior face	5

Peterson also describes and figures (pp. 64–65) an isolated humerus, which he refers, with much probability, to this genus. In any event, it almost certainly pertained to a creodont. Peterson's description reads:

The right humerus . . . represents that of a smaller animal, about the size of *Hyænodon mustelinus*, though slenderer and relatively less expanded at the head and distal end. As in *Hyænodon* the articulation for the scapula faces almost as much backward as proximally. The tuberosities are wide apart, displaying a wide and shallow bicipital groove. The deltoid crest is not prominent. The supinator ridge is low and poorly developed and the external epicondyle is likewise poorly developed, while the inner condyle is large and perforated by the characteristic foramen. The supratrochlear and anconeal fossae com-

municate by a large foramen characteristic of the genus. The distal trochlea is distinctly typical of *Hyænodon* and quite perfectly answers the description of Professor Scott, who states that the trochlea "is divided into three facets, of which the inner one is both the widest and the highest, while the outer one is very narrow; the median facet is a broad and strongly convex [ridge]."

I can hardly agree with Mr. Peterson in saying that this humerus is of about the size of that of *H. mustelinus*, for, according to my measurements and Peterson's natural-size figure, this bone is but four-fifths as long as in the White River species. The shaft is slender, its diameter diminishing downward regularly from the proximal end to the distal expansion, and, for the lower third of its length, it is quite cylindrical. This shaft has a gentle longitudinal curvature, making the posterior face rather concave, though the anterior face is but slightly convex. The internal epicondyle is relatively very large, decidedly more so than in the White River hyaenodonts. On the whole, it seems that Peterson's reference of this humerus is probably correct, if not to the genus, at least to the family.

MEASUREMENTS

Humerus, length from head	80 mm.
Humerus, width of proximal end	13
Humerus, width of distal end, over epicondyle	18
Humerus, width of distal trochlea	13

Horizon: Lapoint, Duchesne River.

Locality: Jaw fragment and humerus, Teleodus Quarry, 11 miles N.W. of Vernal, Utah.

SUBORDER **FISSIPEDIA**, FISCHER DE WALDHEIM

SUPERFAMILY **MIACOIDEA** TEILHARD DE CHARDIN

FAMILY **MIACIDAE**

Having transferred this family from the Creodonta to the Fissipedia, I feel that it is necessary either to include it in one of Flower's superfamilies or to adopt Teilhard de Chardin's term, Miacoidea, as a group-name for it. This superfamily includes exceedingly ancient and primitive carnivores, which, there is much reason to believe, were, directly or indirectly, ancestral to all of the other fissiped superfamilies and, therefore, not to be included in any one of them. The Duchesne River beds have never yielded any determinable fossils of miacoids or cynoids, but scattered foot-bones, metapodials and phalanges, have been obtained, which indicate the presence of Fissipedia, and, very probably, these are either miacoids or cynoids.

SUPERFAMILY **AELUROIDEA** FLOWER

FAMILY **FELIDAE** GRAY

SUBFAMILY **MACHAIRODONTINAE** GILL

EOSICTIS gen. nov.

The type specimen of the species for which this genus is proposed is a most interesting and suggestive but exasperatingly incomplete fossil; it certainly seems to indicate a primitive sabre-tooth, though the upper canine is almost the only characteristic feature that is left, and that is of such exceptional form as to render the systematic position of the creature open to some question. The specimen is a fragment of the right upper jaw, with the canine, p^2 and ^{3} intact, the root of p^1 and the anterior half of p^4 the premaxillary and all the incisors have been lost. Associated with the jaw-fragment is a portion of the right squamosal, which retains the root of the zygomatic process and the complete glenoid cavity.

The upper *canine* is a large and formidable fang, or tusk, as long, proportionally, as in *Dinictis*, the sabre of which it resembles, though with certain striking differences. The external side of the tooth is simple and convex, but the lingual side is very different from that seen in any of the White River or later machairodonts, and decidedly peculiar. Prominent and conspicuous enamel ridges run down the anterior and posterior borders for the full height of the crown. The posterior ridge forms the border, but the anterior one is demarcated by a fine groove. Between the ridges the lingual face is convex, but only moderately so. The tusk is so much compressed laterally, that the antero-posterior diameter greatly exceeds the transverse, and the tooth, aside from the internal ridges, suggests the sabre form, although it is but slightly curved and is as straight as in *Dinictis*. A peculiar feature is the anterior face, which is not an edge, as it is in all other known machairodonts, but a narrow surface, and, seen from the front, resembles a rodent incisor. The canine, thus, has much about it that is peculiar; it suggests, nevertheless, a laniary sabre, at the first glance, chiefly because of its great length, projecting relatively far below the level of the premolars, and its thinness transversely, which is so different from the thick oval cross-section of the canine of true felines.

The *premolars* are four in number and are closely set, without diastemata. P^1 has lost its crown, but the root remains and is in close contact with that of the canine; this root is grooved, as though originally double, and, though curiously stout, it can have supported but a small and simple crown. P^2 is two-rooted and its crown is a simple, compressed, and trenchant cone, without accessory cusps or tubercles. P^3 is decidedly larger than p^2, but similar in form and equally simple; these three premolars are all small, while p^4 is very much larger, especially in dorso-ventral height of crown, and, though the posterior cusp has been broken off, the tooth was evidently a sectorial. The principal cusp is a high, sharp-pointed, and compressed cone, without anterior basal cusp, as is also true of the White River sabre-tooth *Dinictis*. The posterior part of the shearing blade, or tritocone, which was originally present, has been lost, and its size and shape can only be estimated.

This dentition, so far as it is preserved, is more sim-

ple and primitive than that in any of the later machairodonts, but, in spite of its incompleteness, the fossil is, most probably, one of the Fissipedia and not a creodont. One is tempted to identify it with the extraordinary *Apataelurus*, of the Uinta, the upper teeth of which are unknown, but that "sham sabre-tooth" is an undoubted creodont,[10] which *Eosictis*, almost certainly, is not; the very large size of p^4 is against any such reference. However, the loss of the upper molars and of all the lower teeth makes it impossible to be entirely confident of the reference.

On a preceding page it was mentioned that a small fragment of the squamosal bone was found in association with the jaw just described, and this is of considerable interest, for it includes an uninjured glenoid cavity, which is very catlike and might almost belong to the White River *Eusmilus*, which has the most advanced and highly specialized dentition and jaw-mechanism of all known sabre-tooths of whatever geological date.[11] In *Eosictis* the glenoid cavity is very deeply concave in the antero-posterior dimension, with preglenoid and postglenoid processes of almost equal height, thus giving to the cavity a remarkably catlike appearance, though the preglenoid process is higher than in *Felis* and more as in *Eusmilus*. Unless this skull fragment has a merely accidental association with the jaw, it lends strong support to the reference of this genus to the machairodonts. In view of the extreme rarity of fossils in the Duchesne River beds, such accidental association is very unlikely.

Dr. John Clark informs me that, when the type specimen was discovered, crumbling remains of a skull and impressions in the matrix suggested to him, even before the teeth were fully exposed, that the animal was a cat, in the broad sense of the term. Assuming the correctness of this reference, the fossil is of the greatest interest, as recording the first known appearance of the cat family and the sabre-tooth subfamily in the Western Hemisphere.

SYSTEMATIC POSITION OF *EOSICTIS*

Examination of this fossil immediately suggests the question of its possible relation to the "sham sabre-tooth" creodont, *Apataelurus*,[12] of the preceding Uinta formation. Comparison of the two supposedly distinct genera is made difficult by the fact that they have no structures in common, one having only the lower jaw and teeth, the other only an incomplete upper dentition. It is, however, possible to make certain inferences from each fossil as to the missing parts. *Apataelurus* is a creodont, which imitates a sabre-tooth cat in a really astonishing way, though not more surprisingly than the imitation of the same group displayed by the marsupial *Thylacosmilus*, of the Argentinian Pliocene. No doubt this creodont had two pairs of carnassial teeth, p^4 and m_1 and m^1 and m_2, of which the latter pair were much the larger and more specialized, while m_1 is notably small and is exceeded in size by p_4. From the small size of m_1 we may infer that its fellow in the shearing pair, p^4, was likewise small and that the enlarged and efficient pair of carnassials was made up of molars, m^1 and m^2. All this is typically creodont and different from the fissiped arrangement, in which there are either no carnassials, as in the bears, or else only a single pair, always made up of p^4 and m_1.

As to *Eosictis*, with the incomplete p^4 and in the absence of the mandible and all the lower teeth, it would be premature to make any positive statements. On the other hand, the very large relative size of p^4, which so conspicuously exceeds the other premolars, makes it extremely probable that this tooth was one of the single sectorial pair, typically the fissiped arrangement. If this is true, there can be no hesitation in referring *Eosictis* to the Fissipedia, and the character of the canine strongly suggests the machairodonts.

Eosictis avinoffi sp. nov.

The specific name is given in recognition of the extraordinary kindness of Director Avinoff to Mr. Horsfall and myself during our visit to the Carnegie Museum in October and November 1941.

As there is but one species, it is unnecessary to add a specific diagnosis, other than the dimensions: the catalogue number is C.M. No. 11,847.

MEASUREMENTS

Upper canine, antero-posterior diameter	16 mm.
Upper canine, height of crown (enamel cap)	34
Upper premolar series, length (est.)	40.7
P^2, antero-posterior diameter	10
P^2, height of crown	6.6
P^3, anterior-posterior diameter	10
P^3, height of crown	8
P^4, anterior-posterior diameter (est.)	18
P^4, height of protocone	13.6

Horizon: Duchesne River, Halfway substage.
Locality: West Fork of Halfway Hollow, Uinta County, Utah.

ORDER **RODENTIA** CUVIER

Like all other small mammals, rodents are disproportionally rare in the Duchesne River beds; Peterson lists only two species, which have been described by Burke.

FAMILY **ADJIDAUMIDAE** MILLER AND GIDLEY

As I have had no opportunity to examine the Duchesne River rodents, the only course open to me is to reproduce Burke's descriptions of the Carnegie Museum material.

[10] Scott, W. B., *Ann. Carnegie Mus.* **27**: 113–120, 1938.
[11] Scott and Jepsen, *Trans. Amer. Philos. Soc.* **28**: 141–146, 1936.
[12] Scott, W. B., *Ann. Carnegie Mus.* **27**: 113, 1938.

PROTADJIDAUMO Burke

Protadjidaumo Burke, *Ann. Carnegie Mus.* **23**: 394, 1934.

Diagnosis: Pattern of cheek-teeth essentially as in *Adjidaumo*, but cusps more bunoid and connecting crests weaker, P_4 with low posterior cingulum connecting with hypolophid, anterior valley of M_1 opening freely externally.

If not directly ancestral to the genus *Adjidaumo* in later Oligocene horizons, *Protadjidaumo* is certainly closely related to the latter genus. By converting the posterior cingulum of P_4 into a cingulum crest (a process which appears to be under way already), developing a dam near the external exit of the anterior valley of M_1, raising and strengthening its connecting crests and attaining a more crescentic condition of its outer cusps, *Protadjidaumo typus* might easily give rise to a conservative species of *Adjidaumo* such as *Adjidaumo minutus* (Cope).[13]

Protadjidaumo typus Burke

Protadjidaumo typus Burke, *Ann. Carnegie Mus.* **23**: 394, 1934.

Except for the dimensions, Burke gives no diagnosis of this species:

Measurements

P_4 antero-posterior	1.1 mm.
P_4 transverse	1.0
M_1 antero-posterior	1.1
M_1 transverse	1.1
M_2 antero-posterior	1.2
M_2 transverse	1.1

Horizon: Duchesne River Oligocene Series, Lapoint Horizon.
Locality: Fourteen miles west of Vernal, Uinta County, Utah, one-half mile north of Vernal-Lapoint road.

Family PARAMYIDAE Miller and Gidley

LEPTOTOMUS Matthew

Leptotomus Matthew, *Bull. Amer. Mus. Nat. Hist.* **28**: 50, 1910. (Subgenus of *Paramys*.)
Leptotomus Burke, *Ann. Carnegie Mus.* **23**: 391, 1934.

Diagnosis: Cheek teeth brachyodont, the pattern recalling that of *Prosciurus*: low intermediate tubercles on protolophs and metalophs of P^4, M^1 and M^2, the metaconules more prominent than the protoconules; external intermediate cuspules on P^4 and the molars; molars with prominent anterior but much reduced posterior cingula and slight internal enamel invaginations. Low posterior transverse crest in M^3. P^4 molariform, its anterior cingulum more reduced than that of molars, the posterior cingulum prominent, the metacone and metaconule nearly equal in size. Species larger than *Leptotomus grangeri* Matthew.

Anterior to P^4 the maxillary is shattered and P^3 is not preserved. P^4 is almost as much enlarged as the molars, is not prolonged forward, and has a well-developed anterior cingulum. Its anterior cross-valley is not as wide as the corresponding cross-valleys in the molars, and the posterior cingulum is low. P^4 bears a very small cuspule between the external cusps.

In the molars the anterior cingula are well-developed. The posterior cingula were much reduced. In M^1 the external intermediate cuspule is prominent. A slight enamel invagination occurs in the internal face of this molar. M^2 is badly worn in the region of the protoloph, but the presence of a low protoconule is still indicated. The external intermediate cuspule is somewhat larger than the corresponding cuspule in M^1, and an enamel invagination in the postero-internal wall of the tooth is a little shallower than the invagination seen in M^1. M^3 bears a complete anterior transverse crest. The posterior basin has been badly worn, but a short crest runs internally from what appears to be a low external intermediate cuspule, and there are indications of a low posterior transverse crest.

The zygoma is heavy and sturdy, and begins to flare out laterally posterior to M^1. Anteriorly it extends obliquely upward and forward.[14]

Leptotomus kayi Burke

Leptotomus kayi Burke, *Ann. Carnegie Mus.* **23**: 391, 1934.

This species agrees best with a smaller form, probably a distinct species, which is found in the Myton Member of the Uinta Eocene Series, the lower jaw of which resembles that found in *Leptotomus grangeri* Matthew. P^4 was the only superior cheek-tooth found with the type of *Leptotomus grangeri* Matthew. From it, P^4 of both *Leptotomus kayi* m. and the Myton Member species differ in being more molariform, the trigonal outline seen in P^4 of *Leptotomus grangeri* Matthew is less evident, and the anterior cingulum is more reduced. In *Leptotomus kayi* m. the metacone and metaconule appear to be nearer the same size than in *Leptotomus grangeri* Matthew, and the Duchesne River Oligocene species exceeds both *Leptotomus grangeri* Matthew and the species from the Myton Member in size.

Measurements

P^4 antero-posterior	4.8 mm.
P^4 transverse	5.4
M^1 antero-posterior	4.8
M^1 transverse	5.7
M^2 antero-posterior	4.9
M^2 transverse	5.0
M^3 antero-posterior	5.1
M^3 transverse	5.0[15]

Horizon: Duchesne River near base of Randlett substage.
Locality: 2 miles N.E. of Randlett Point, Uinta County, Utah.

Order LAGOMORPHA Brandt

Family LEPORIDAE Gray

MYTONOLAGUS Burke

Mytonolagus Burke, *Ann. Carnegie Mus.* **23**: 400, 1934.

Mytonolagus sp. Peterson

Mytonolagus sp. Peterson, *Ann. Carnegie Mus.* **23**: 374, 1934.

Peterson lists, without description or specific name, this species of a Uinta genus, and, so far as I can discover, Burke merely mentions it in passing: "Both the Duchesne River and Wagonhound specimens are fragmentary, but are referred to the same genus as the Myton fossils."

Order ARTIODACTYLA Owen

Throughout the Lower and Middle Eocene of North America the preponderant ungulates were perisso-

[13] Burke, J. J., *Ann. Carnegie Mus.* **23**: 394, 1934.

[14] *Ibid.*: 392–393.

[15] *Ibid.*: 393.

dactyls and artiodactyls were rare. Between the Washakie and the Uinta there was a striking change in the fauna, though there is no distinct physical or stratigraphic break at this level. The outstanding feature of the change is the great increase in the number of artiodactyls, especially the selenodonts. This revolutionary change, which is apparently so sudden and unheralded, is obviously to be interpreted as an immigration, though whence that migration came is not altogether clear. Some of the families were undoubtedly derived from eastern Asia, but the two most abundant of the newly appearing families, the Merycoidodontidae and the Agriochoeridae, are not definitely known to have occurred in the Old World. These preëminently North American groups, which flourished so conspicuously throughout the Oligocene, Miocene, and early Pliocene, may have arrived in the western United States from some other part of North America. On the whole, however, it seems more probable that the region which is now Siberia, the early Tertiary mammals of which are still unknown, was the source of origin. Mongolia may have contributed some of the groups, as it almost certainly did to the White River immigration, but hardly the most abundant and characteristic families.

The list of artiodactyl families which form part of the Duchesne River fauna is quite considerable, especially when it is remembered how very scanty that fauna is. Other probably immigrant families which arrived in the Wasatch and continued through the Duchesne River, are the Dichobunidae and the Helohyidae. According to my views, the achaenodont subfamily of the Entelodontidae did not reach the White River, and whether it occurs in the Duchesne River, will depend upon the disposition made of Colbert's enigmatic *Brachyhyops*,[16] which he refers to the Choeropotamidae. If that reference is confirmed, *Brachyhyops* is assuredly an immigrant, but it may prove to be an achaenodont, in which case it is probably of North American origin. The uncertainty of determination arises from the abraded condition of the teeth, from which all trace of cuspidation has been worn away.

It is my belief that no forerunner of any pecoran family occurs in the Eocene or Oligocene of North America, for I refer all the selenodont groups of these epochs to the Tylopoda, in which I would include the Camelidae, Hypertragulidae, Merycoidodontidae, and Agriochoeridae.

Suborder **PALAEODONTA** Matthew

Matthew proposed this term to include the early and primitive artiodactyls, for which no appropriate place could be found in any of Flower's four suborders.

Family **HELOHYIDAE** Marsh

HELOHYUS Marsh

?Helohyus sp. Peterson

Peterson refers,[17] though but tentatively, certain scattered teeth to this genus, without venturing to give any specific name. It seems unlikely that a typically Bridger genus should persist to so late a period as the Duchesne River, but it is not at all impossible.

According to Colbert's view, the European family of the Choeropotamidae is probably represented in this fauna by the extraordinary genus which he named *Brachyhyops*.

Family ?**CHOEROPOTAMIDAE** Owen

The Carnegie Museum expedition of 1934, directed by Mr. J. LeRoy Kay, explored the Beaver Divide, Wyoming, and collected some new and extremely interesting fossils, which, as previously explained, are here provisionally included in the Duchesne River fauna. One of these, a well-preserved but much distorted skull, without mandible, was described by Dr. E. H. Colbert, of the American Museum of Natural History, who named it *Brachyhyops wyomingensis*.

BRACHYHYOPS Colbert

Brachyhyops Colbert, *Am. Jour. Sci.*, ser. 5, **33**: 473, 1937.
Brachyhyops Colbert, *Ann. Carnegie Mus.* **27**: 87, 1938.

Diagnosis: Of medium size, the skull being of a length comparable to that of the skull of a modern peccary. Dentition $^{3-}(?)^{-1-4-3}$; lower dentition unknown. Cheek teeth closely comparable to those of *Chœropotamus*, *Helohyus*, *Achænodon* and *Parahyus*, being near to the latter in size. Cranium broad, having widely separated parietal crests. Orbit closed posteriorly; situated above the last two molars. Muzzle relatively short, so that the postorbital length exceeds somewhat the preorbital length of the skull. Zygomatic arch vertically expanded behind and below the orbit, somewhat in the manner of the entelodonts. Skull transversely broad, due to the lateral expansion of the arches. Glenoids shallow and broad and relatively low, being about on a level with the occlusal line of the upper cheek teeth. Paroccipital processes short and pterygoids weak. Posterior nares extending to the middle of the upper third molar. Basicranium primitive, the arrangement of the foramina being like that in the dichobunids.[18]

Colbert's excellent, detailed description leaves little room for additions and is, therefore, reproduced in somewhat shortened form, with the addition of merely a few minor details.

The holotype of the genus is a skull (Carnegie Museum, No. 12,048), which lacks the mandible and is much distorted by vertical, or dorso-ventral pressure. It is, however, not difficult to correct the distortion, and there is every reason to believe that the drawings made by the late Mr. Sidney Prentice for

[16] Colbert, E. H., *Ann. Carnegie Mus.* **27**: 87–108, 1938.

[17] Peterson, O. A., *Ann. Carnegie Mus.* **23**: 375, 1934.

[18] Colbert, E. H., *op. cit.*: 87–88.

Dr. Colbert's description and by Mr. R. B. Horsfall for the present paper, give a sufficiently accurate conception of this specimen, which, so far, is entirely unique. It is a curious and unfortunate fact, that so many of the most interesting and significant fossil mammals should remain unique even after long periods of active and meticulous collecting. Marsh's skull of *Tillotherium*, from the Bridger, described in 1873, *Protoptychus* Scott, 1895, and *Eotrigonias* Wood, from the Uinta, and, most remarkable of all, Leidy's *Leptictis*, from the White River, which was named in 1868, are still represented by single specimens, despite the most careful and long continued search. So far, *Brachyhyops* belongs in the same category, and nothing else remotely resembling it has ever been found in any American formation.

DENTITION

The dental formula is: i?, c^1, p^4, m^3. Only upper teeth are known, and, of these, the *incisors*, together with both premaxillae, have been destroyed by weathering. The *canine*, missing on both sides, is shown, by the matrix-filled alveoli, to have been a comparatively large and formidable tusk. It was, evidently, much compressed laterally and seems to have been a laniary sabre. The grinding teeth are arranged in nearly straight lines, without diastemata, and are in such an advanced state of wear, that nothing can be made out concerning their cuspidation.

Of the *premolars*, p^1 and p^4 are in place, on one side or the other, while p^2 and p^3 are represented only by the alveoli. P^1 is small, evidently much the smallest of the cheek-teeth, two-rooted, and with a simple, compressed-conical crown. Likewise, p^2 and p^3 are two-rooted; their alveoli indicate that they are somewhat larger than p^1, which they probably resembled in form. Of p^4, the crown remains, but is so extremely abraded that the cuspidation is unrecognizable. Colbert says (1938: 94), however, that "it gives indications of having a large, single outer cone and a smaller inner cone." Differing from the other premolars, the crown of p^4 is wider transversely than elongate anteroposteriorly, and the alveolus of the inner root is conspicuously larger than the two external ones.

Cuspidation of the *molars* has been removed by abrasion, but it may be confidently assumed that the pattern was bunodont and, presumably, quadritubercular. The three teeth of the series are of different sizes, m^1 being the smallest and m^2 the largest. M^3 is asymmetrical, because the posterior half of the crown is much narrower than the anterior half.

SKULL

Partly on account of the advanced age of the animal before fossilization and, partly, because of its crushed and distorted condition, which has resulted in a multitude of matrix-filled cracks, sutures are seldom clearly visible, and most of those which are shown in the drawings are restorations made from faint suggestions. As the outlines of the various bones of the skull are so seldom distinctly marked, it will be advisable to describe the five different aspects of the skull.

Side View.—The disproportionate shortness of the preorbital and the elongation of the postorbital region are conspicuous features. Even after making all due allowance for the effects of downcrushing, this skull is very low dorso-ventrally. The orbit is relatively small, completely encircled in bone and placed high in the face, seemingly projecting above the level of the forehead. A comparison of the late Mr. Prentice's drawing of the side view of the skull (Colbert's fig. 3) with that which Mr. Horsfall has made for this paper (pl. VI, fig. 1) will show how the two artists have differed in several minor details in their manner of compensating the effects of distortion. Mr. Horsfall's drawing shows the roof of the orbit projecting above the level of the forehead, while Mr. Prentice has raised it less. Likewise, there are differences in the shape given to the anterior end of the zygomatic process of the squamosal, the squamoso-jugal suture, and that between the jugal and the postorbital process of the frontal. Mr. Horsfall has restored the sutures bounding the lachrymal, maxillary, nasals, and frontals in a way that Mr. Prentice has refrained from doing, but, in my judgment, these sutures are substantially correct, according to the faint indications. Among ungulates of so early a geological date, *Brachyhyops* is the only known instance of the closed orbit, and the flat-topped cranium is likewise unique. In shape, the orbit seems to be circular and to have suffered but slightly from distortion.

Another conspicuous feature of the side view of this skull is the relatively great dorso-ventral breadth of the jugal, which suggests an incipient suborbital process such as characterizes the White River genera, *Archaeotherium* and *Entelodon*.

The *maxillary* is long and low, extending beneath the orbit, of which it forms the floor; at the other end of the bone the canine alveolus forms a facial convexity. The infraorbital foramen is rather small and is placed low down and relatively far in front of the orbit, opening above the hinder part of p^3. The *lachrymal* is of somewhat uncertain size and shape, but appears to be large and well extended upon the face and to form a considerable part of the anterior boundary of the orbit; apparently the foramen is concealed within the orbit, and the spine is a vestigial tubercle.

The *jugal* is a comparatively large and massive bone and bounds the orbit below, in front and behind, making up a large part of the facial region; its ventral border is raised and thickened and converts the external surface into a shallow concavity. This border descends from the anterior end of the maxillary to the bottom of the suborbital process, whence it rises to the subzygomatic extension. Posteriorly, the jugal forms

about half of the hinder orbital margin, has a relatively long suture with the postorbital process of the frontal, and is deeply notched by the zygomatic process of the squamosal, beneath which it extends almost to the glenoid cavity.

The zygomatic process of the *squamosal* is conspicuously short and stout, broad dorso-ventrally, and thick transversely. The external surface is concave, the concavity having, presumably, been deepened by the downcrushing; the postglenoid process, which is visible from the side, projects downward below the level of the zygoma. No distinct post-tympanic process is to be seen, but, if it was originally present, it must have coalesced with the paroccipital. The entrance to the auditory meatus is a relatively broad space between the postglenoid and paroccipital processes, but this region is somewhat damaged on both sides and is, therefore, difficult to interpret; the paroccipital is short and stout, ending distally in a bluntly rounded point.

The cranial portion of the squamosal is comparatively small and articulates with the parietal by one of the few distinctly visible sutures which this specimen displays. Except for the squamosal, the whole lateral wall of the brain-case appears to be formed by the *parietal*, for the limits of the supra- and exoccipitals are quite indistinguishable. The brain-case is of small capacity, and its external portion is but slightly convex on the outer side, becoming concave dorsally, where the temporal ridge bounds it above. Posteriorly, the parietals are drawn out into the winglike occipital processes, which, though less extended than in the White River *Merycoidodon*, are yet very conspicuous and overhang the condyles. The ventral portion of the exoccipitals extends strongly backward and is but partially concealed, in side view, by the paroccipital; the condyle projects obliquely posteriorly and ventrally and is a conspicuous feature in this aspect of the skull.

Top View.—This is, perhaps, the most peculiar and exceptional of all the different views and emphasizes the completely isolated position of *Brachyhyops* among the known North American artiodactyls. The most unusual feature of this skull is the broad, flattened cranial roof, the sagittal crest having been reduced to a very low ridge, the presence of which may be principally due to the great age of this individual. The crest appears to have been buried in the sinus-filled cranial roof. This flattening is all the more remarkable, because the brain capacity was so limited, and was brought about by the great expansion of the cranial sinuses and the diploetic structure of the skull roof, and was, no doubt, correlated with the growth of the temporal muscles. The perissodactyl family of the brontotheres offers an interesting parallel to this condition. As late as the Middle Eocene, the brontotheres all had a long, prominent sagittal crest; then, in the Upper Eocene and Lower Oligocene the crest disappeared and the top of the cranium became broad and flat, yet the brain did not keep pace with this development and remained absurdly small.

Returning to *Brachyhyops*, we may note that, in its present crushed state, the cranial roof is concave on each side of the sagittal ridge, but how far these concavities were produced by the distortion, it is difficult to estimate.

An even more striking feature in the dorsal aspect of this skull is its great breadth in proportion to the antero-posterior length; the ratio, making the necessary allowance for the missing premaxillaries, is, approximately, length 3 : 2 width. This relatively great breadth is due to the remarkable expansion of the zygomatic arches, which, in connection with the narrow brain-case, makes the temporal openings exaggeratedly large and of a somewhat irregularly circular shape. The postorbital part of the skull, whether seen from above or below, has a curiously rectangular outline (pl. VI, figs. 1*a*, 1*b*), the anterior border of which bisects the postorbital processes of the frontals and the hinder border passes through the postglenoids. The vertical aspect, dorsal or ventral, strongly suggests that of the White River entelodont, *Archaeotherium*, though the brain capacity is not quite so far reduced as in that genus. The small orbits seem to have a somewhat oblique position, presenting slightly upward, as well as laterally, although, here again, this may be a result of distortion. Assuming that the obliquity was original and not entirely due to crushing, and taking it together with the projection of the orbital roof above the plane of the forehead, the whole structure suggests that the animal was aquatic in habits. However, the evidence is insufficient to justify positive statements in this matter, especially since it is so difficult to estimate the amount of displacement.

No sutures are visible in the cranial roof and those which appear in the drawings of the facial region are largely conjectural. The two artists differ somewhat in their interpretation of the effects of distortion and shattering of the bones, but both agree in making the nasals narrow and transversely convex. In this view, the face narrows gradually forward from the orbits to a point above the second premolar, thence broadening to the muzzle, the breadth of which is increased by the canine sheaths. The comparative massiveness of the zygomatic arches is more conspicuous in this aspect of the skull than in the side view, as is also their great lateral extension, the cranial roof making up less than one-third of the total skull-width. The backward slope of the occiput is plainly shown and also the median notch in the dorsal margin of the foramen magnum.

Base View.—The ventral side of the skull shows decidedly less distortion than the dorsal side, suggesting that the downcrushing had pushed the comparatively thin and fragile roof down against an unyielding base. The outlines of the skull, zygomatic arches and

temporal openings are, of course, the same as in the top view, but the massiveness of the arches and their wide extension from the sides of the skull, seem to be even more striking when seen from below. The bony palate is elongate, narrow and but slightly concave; it broadens anteriorly as the tooth-rows diverge. The sutures between the palatine bones and the palatine processes of the maxillaries remain distinct; the former are relatively small and extend forward only to the hinder edge of m^1. The posterior palatine foramina are comparatively large and open between the palatine bones and the maxillary plates. The posterior nares are relatively small and are placed far back, their front margin on a line with the middle of m^3; the narial canal is, consequently, short.

The basioccipital is broad and bears a keel; the condyles are small, transversely extended and widely separated below. No trace of a tympanic bulla remains and its original presence or absence is a matter of conjecture.

Of the *Cranial Foramina*, Colbert says: [19]

> The ethmoid and optic foramina are not discernible, but the foramen lacerum anterius and foramen rotundum are plainly visible, enclosed in a common vestibule. The foramen ovale is situated just medially to the internal border of the glenoid, while the foramen lacerum medius [*sic*] and the opening for the eustachian canal are behind it and separated from it by a bony ridge. The foramen lacerum anterius is isolated and located opposite and median to the postglenoid process, while the stylomastoid foramen is postero-lateral to the foramen lacerum posterius. The condylar foramen would seem to be single.
>
> The arrangement of the basicranial foramina described above is characteristic of a primitive mammal, in that there is little tendency toward fusion or concrescence of the various openings in the cranial floor.
>
> This genus displays its relationships to the primitive bunodont artiodactyls by reason of the lack of any appreciable compression of the structures on the floor of the brain case. Thus it may be contrasted with the achaenodonts and entelodonts in which the basicranium is greatly compressed by the backward shift of the glenoids.

Rear View.—This aspect of the skull is quite as strange and exceptional as the top and side views and has suffered much less from the effects of compression, unintelligible as that fact may be. The downcrushing has affected principally the top of the cranial regions, especially along the median line and in front of the occiput. This view shows plainly how little of the great skull-width is made up by the brain-case; that breadth is principally due to the wide expansion of the zygomatic arches, each one of which is nearly as broad as the occiput. The sutures are so obliterated, that the limits of the various occipital elements are indistinguishable. In the rear view the skull is conspicuously low and wide and the effects of crushing appear especially in several matrix-filled cracks, but there is little dislocation or faulting. The dorsal half of the occiput is made quite deeply concave by the wing-like extensions of the parietals, which are accompanied by extensions of the supraoccipital. The crest of the inion would seem to have projected but little above the cranial roof, before the downcrushing had much increased its prominence, for it was little, or not at all involved in that movement. Distally, the occipital surface becomes moderately convex and slopes downward and backward to the foramen magnum, forming the prominence which is conspicuous in the lateral view. The dorsal border of the foramen has a median notch, on each side of which the exoccipital forms a projection, ending in a bluntly rounded tip; notch and projections are plainly visible in figures 1*a* and 1*b* of plate VI. On each side of the median convexity, the occiput is bounded by a deep groove, setting it off from the paroccipital process. These processes are short and stout and project but slightly below the condyles; though they are not quite complete, it is evident that the paroccipitals have lost but little of their length. The foramen magnum is unusually wide transversely and low dorso-ventrally, proportions which seem not to have been much affected by the downcrushing.

Front View.—It is the anterior portion of the skull which has suffered most from the crushing and distortion, yet, even so, the anterior aspect displays certain characteristics which are not unworthy of mention. Seen from before, this skull is remarkably broad and low, even after making all due allowance for distortion, and gives an altogether different picture from the rear view. In this position, the orbits are especially conspicuous and seem to be larger than when viewed from the side. Their obliquity of position is also peculiar, as they slope from behind forward and inward, as well as downward and outward; it is this double obliquity, which makes the orbits present upward and forward, as well as laterally, and to which their prominence in both top and front views is to be ascribed. The great expansion of the zygomatic arches is not conspicuous in this position, except on the left side, where the spread has been manifestly increased by the downward pressure; on the right side, where the bones are in almost their natural position and the outer face of the arch is nearly vertical, the zygoma is largely concealed from the front by the prominent orbit and is given great dorso-ventral extent by the suborbital process of the jugal. The flat cranial roof is conspicuous in anterior view, because of the upward slope from orbit to crest of the inion, and is highly characteristic, for no other known Eocene, or Oligocene artiodactyl has a skull of this shape, though the White River peccary, *Perchoerus*, approximates it. Otherwise, this skull, when seen from the front, has a distinct resemblance to that of one of the larger oreodonts, such as *Promerycochoerus*. To this effect, the closed orbits largely contribute.

[19] Colbert, E. H., *op. cit.*

SYSTEMATIC POSITION OF *BRACHYHYOPS*

Dr. Colbert had the very great kindness to permit me to reproduce his figures of the *Brachyhyops* skull in the second edition of my *Land Mammals*,[20] in advance of his own publication.[21] In that work I tentatively referred the genus to the achaenodont subfamily of the Entelodontidae, though feeling little confidence in the assignment. Colbert, after an elaborate analysis of resemblances and differences, preferred to include it temporarily in the European family of the Choeropotamidae, to which he also referred the Wasatch genus *Parahyus*. That the two opinions differ but slightly, is shown by the fact that *Parahyus* has never been satisfactorily distinguished from *Achaenodon*, and Colbert's diagram of the phylogeny of the bunodont artiodactyls shows the Achaenodontinae and the Choeropotamidae in close juxtaposition. As it is impossible to decide the issue and will remain so, until the unworn dentition shall have been discovered, I have no objection to following Colbert's example. Even that hoped-for discovery may not solve the problem of the flat-topped cranium. For an explanation of that most exceptional condition it will be necessary to find one or more intermediate steps of gradation between the cranium with long and prominent sagittal crest and that with flattened, diploë-filled roof. All that we can say, with assurance, is that *Brachyhyops* is one of the primitive bunodont artiodactyls which Matthew grouped together under the name of Palaeodonta.

Brachyhyops wyomingensis Colbert

Brachyhyops wyomingensis Colbert, *Amer. Jour. Sci.*, Ser. 5, **23**: 473, 1933.
Idem: Ann. Carnegie Mus. **27**: 87–108, 1938.

The author gives no separate specific diagnosis, merely saying that the description of the species is the same as that of the genus. In the subjoined table the measurements are mine and where those given by Colbert are different, his figures are added in parentheses.

MEASUREMENTS

Upper canine, antero-posterior diameter of alveolus (est.)	15 mm.
Upper canine, transverse diameter of alveolus (est.)	11
Upper cheek-tooth series, length	109
Upper premolar series, length	63
P^1, antero-posterior diameter	10
P^1, transverse diameter	5
P^2, antero-posterior diameter of socket	17
P^3, antero-posterior diameter of socket	?15
P^4, antero-posterior diameter	15
P^4, transverse diameter	15
Upper molar series, length	44
M^1, antero-posterior diameter	14
M^1, transverse diameter	17
M^2, antero-posterior diameter	17 mm.
M^2, transverse diameter	20
M^3, antero-posterior diameter	15
M^3, transverse diameter	18
Skull, length occ. cond. to hinder edge of canine	206
Face, length anterior margin of orbit to hinder edge of canine	76
Skull, width over suborbital processes	158(161)
Skull, width at postglenoid processes	150
Skull, width over paroccipitals	77
Occiput, width across crest of inion	62
Occiput, height fr. basiocc. between condyles	59
Cranium, least width over temporal ridges	47
Temporal opening, antero-posterior diameter (right)	56
Temporal opening, transverse diameter (right)	43
Jugal, suborbital depth	54 (45)
Palate, width at canines	36
Palate, width at m^3	20

Horizon: "Uppermost level of the Uinta formation, immediately beneath the basal Oligocene [White River] agglomerate," Colbert. Probably Duchesne River.
Locality: Beaver Divide, ½ mile north of Wagon Bed Spring, Wyoming.

FAMILY **DICHOBUNIDAE** GILL

This is a characteristic Eocene family and to it Sinclair [22] referred all the Wasatch and Bridger artiodactyls, except the swine-like achaenodonts. The European *Dichobune*, which Schlosser believed to be ancestral to all the Pecora and Tragulina (and which may nearly represent the ancestor of the Tylopoda, as well) differs from all the American genera which have quinque-tuberculate molars, in having the unpaired fifth cusp in the posterior half of the crown. It is, thus, a metaconule, not a protoconule, which it is in all of the American genera. The occurrence in the Duchesne River of representatives of the dichobunids is an interesting survival of Eocene mammals.

PENTACEMYLUS PETERSON

Pentacemylus Peterson, *Ann. Carnegie Mus.* **21**: 72, 1931.

Pentacemylus Type: Two upper molars of the left side, inner portion of P_4, M_1 and M_2 of right side.

Characters obtained from the type material. Upper molars five pointed with protoconule well developed; no evidence of the vestigial hypocone on M^2 which is present in *Bunomeryx*.

Cusps of molars distinctly more crescentic than in *Homacodon* Marsh from the Bridger Eocene, *Bunomeryx* Wortman, and other genera from the Uinta (Horizon C) described later by Peterson. Upper molars of more nearly equal size than those in earlier genera. P_4 with well-developed deuteroconid and paraconid. Lower molars with slightly more advanced selenodont and hypsodont condition than in genera from the Bridger and the Uinta.

With the advanced condition of the cheek-dentition from that of the *Homacodonts* found in the lower strata there still persists the antero-median tubercle, well developed and entirely separated from the protocone as in *Bunomeryx*. Furthermore, the para- and mesostyles and the cingulum are even better developed than in *Bunomeryx*.

[20] Scott, W. B., *A History of Land Mammals in the Western Hemisphere*, 2nd ed., Macmillan, 1937.
[21] Colbert, E. H., *op. cit.*: 105, fig. 5.
[22] Sinclair, W. J., *Bull. Amer. Mus. Nat. Hist.* **33**: 267–295, 1914.

The well developed meso- and parastyles closely suggest *Protoreodon*, but the latter does not have the heavy cingulum bounding the tooth anteriorly, internally, and posteriorly, as is the case in *Pentacemylus*.

The advanced condition of the lower dentition of *Pentacemylus* consists chiefly in the greater development of the para- and deuteroconids and of the greater height of the tubercles along the buccal side of the molars, when compared with those in *Bunomeryx* in the lower horizons.

The new genus here proposed evidently stands very close to *Bunomeryx* of the lower horizons of the Uinta, while *Hylomeryx*, *Sphenomeryx* and *Mesomeryx* stand perhaps closer to *Homacodon*.

The triangular shape of the upper molars in *Pentacemylus* should be mentioned and the resemblance of these teeth to those of *Bunomeryx* emphasized even more than Peterson has done. According to Wortman's conception of these teeth in the latter genus:

> The full six cusps are found in the first superior molar only, while in the second molar there is but a vestige of the postero-internal cusp or hypocone. The evidence appears to be conclusive, therefore, that the true homological hypocone is in process of retrogressive disappearance, and in proportion as this cusp is reduced, the posterior intermediate is pushed out to take its place.[23]

Stehlin has developed this view in a manner that will be more fully dealt with in the succeeding section of this paper, which describes the Uinta fauna. As a preliminary, it may be mentioned that Stehlin divides the artiodactyls into three groups; (1) Hypoconifera; (2) Cainotheridae; (3) Euartiodactyla, concluding that only in the families Entelodontidae and Dichobunidae is the real hypocone present, the metaconule taking its place in other artiodactyls.[24] The molars of *Pentacemylus* certainly seem to bear this interpretation, but the extension of this conception to the order, in general, is a very different matter, which need not be discussed here.

In the upper molars of *Pentacemylus* the outer crescents have ribbed faces and all three styles are present; they are most prominent on m^2, especially the parastyle. The lower teeth are comparatively simple; the single remaining premolar has lost the outer half of the crown, but the remnant suffices to show the cuspidation. The main cusp, or protoconid, is an acutely pointed, compressed cone, which was evidently trenchant; there is a very distinct anterior basal cusp and a relatively large deuteroconid, both of which are sharp-pointed, and an enamel pocket is enclosed between the latter and the external wall, but no posterior basal cusp is visible. In the lower molars, two of which are preserved, m_1 and m_2, the external cusps are crescentic and enclose the internal ones, which are conical.

Pentacemylus progressus Peterson

Pentacemylus progressus Peterson, *Ann. Carnegie Mus.* **21**: 72, 1931.

Peterson gave no separate description of this species, other than the dimensions, which are repeated below, after verification; where corrections are necessary, the original figures are added in parenthesis.

MEASUREMENTS

M^1, antero-posterior diameter	6.5 mm.
M^1, transverse diameter	8 (7.5)
M^2, antero-posterior diameter (approx.)	6.5
M^2, transverse diameter	8 (7.5)
P_4 to m_2, length	19
M_1, antero-posterior diameter	6 (6.5)
M_1, transverse diameter	4
M_2, antero-posterior diameter	6.5
M_2, transverse diameter	4.5 (4)

Horizon: Duchesne River, Randlett substage.
Locality: 3 miles north of Leota Ranch, Uinta County, Utah.

SUBORDER **TYLOPODA** FLOWER

As just stated, I use this suborder in a much more comprehensive sense than is common among palaeontologists. Briefly stated, it is my conclusion that, in North America, from the upper Eocene to the lower Miocene, the camel tribe took the place which, in the Old World, was held by the Pecora and Tragulina. Aside from dental and skeletal resemblances, there is a remarkable geographical unity among the families here referred to the Tylopoda, which appears in the fact that, with one exception, none of these families has ever been found outside of North America before the Pliocene migrations of the llamas to South America and the true camels to Asia. Most of these families and subfamilies are exclusively North American in known distribution, but I cannot doubt that the earliest origin of all these groups and the common ancestry of all the selenodonts will be found in Asia, perhaps in Mongolia, perhaps in Siberia.

So great is the diversity among the Tylopoda, as here interpreted, so extreme the aberrance of certain families and so great the evolutionary changes that took place within the recorded history of each family, that it is well-nigh impossible to frame a definition of the suborder without rewriting that history; such definition may be dispensed with here.

FAMILY **CAMELIDAE** GRAY

This is an entirely natural and clearly circumscribed group, which, from the early Eocene to the end of the Pleistocene, was conspicuous in North America and, until the late Pliocene, was confined to that continent. Indeed, throughout all that time, horses and camels were the most characteristic elements of the North American fauna. Within this family, there are several distinct tribes, or phyla, which apparently began their divergent careers in White River times. The giraffe-like camels, the gazelle-like camels and the giant llama-camels are the most important of these tribes, but in the Duchesne River, as in the Uinta, only the single stem has been found. The occurrence of the very primitive *Eotylopus* in the lowest White River, or

[23] Wortman, J. L., *Bull. Amer. Mus. Nat. Hist.* **10**: 101, 1898.
[24] Stehlin, H. G., *Abhand. d. schweiz. Paläont. Ges.* **27**: 1910.

Chadron substage, is an indication that other tribes remain to be discovered in the Duchesne River, if not in the Uinta, also. Two presumably Duchesne River genera have been named, one from the Uinta Basin in Utah, the other from Beaver Divide in Wyoming.

CAMELODON Granger

Camelodon Granger, *Bull. Amer. Mus. Nat. Hist.* **28**: 248, 1910.

The original description reads:

An extremely slender-jawed type of selenodont artiodactyl with the teeth, especially the premolars and the third molar, and *with a long diastema between the second and third premolars*, the latter character not being observed in other Uinta genera of this group. The second and third premolars are rather simple, compressed, and trenchant. Each has a long posterior crest and a shorter, more abrupt anterior one. On each tooth, but more marked on P_2, there is also a rudimentary internal posterior crest, running backward and somewhat inward from the tip of the protocone, and a long, narrow valley between it and the external posterior crest, a character well shown in the type of *Leptotragulus profectus* Matthew from the Titanotherium beds of Pipestone Springs, Montana; on P_3 the posterior and anterior basal cusps are barely indicated. In addition to strong fore and hind basal cusps there is [on P_4] a large cusp on the posterior inner face of the main cusp or protocone and a very small one on the inner side of the posterior basal cusp. The first and second molars are too much worn to show important characters. The last molar is very long and narrow, with well-rounded outer crescents and a strong fifth lobe with a median ridge and a small cusp on its inner side, as in *Protylopus*. There is a mental foramen below the second premolar. The symphysis extends backward to the posterior edge of the second premolar.

This genus shows strong resemblances to both *Leptotragulus* and *Protylopus*, especially in the premolar construction, and for that reason is placed in the Camelidae. It differs from *Leptotragulus* in the more simple P_2 and P_3 and the more complicated P_4. From *Protylopus* it is distinguished by the more selenodont character of the molars and the greater complication of P_4. *Leptomeryx* differs in having strong anterior and posterior basal cusps on P_2 and P_3, a broader P_4, and more highly specialized molars. *Hypertragulus* resembles the present genus in having a diastema back of P_2, but the premolars are much narrower antero-posteriorly, with high, sharp, pointed cusps, while in *Camelodon* these teeth are broad, with low, blunt cusps.

This description I have verified from the type-specimen and find it unnecessary to add anything, except to emphasize the difference from the Uinta camel, *Protylopus*, in the well-marked diastema between p_2 and p_3. Even in the White River *Poëbrotherium eximium* the diastemata are incipient. Granger gives no separate diagnosis of the species and, as there is but one species, *C. arapahovius*, the measurements of the type will suffice for that purpose. In the table below Granger's measurements are in parentheses.

Camelodon arapahovius Granger

Camelodon arapahovius Granger, *Bull. Amer. Mus. Nat. Hist.* **28**: 248, 1910.

This species is somewhat smaller than Peterson's *Poabromylus kayi*, which it resembles in many respects, yet manifestly belongs to a different genus.

In the following table, where Granger's measurements differ from mine, they are given in parentheses.

Measurements

Lower cheek-tooth series, length p_2–m_3 inc.	51 mm.
P_2, antero-posterior diameter	6
P_2, transverse diameter	2
Diastema between p_2 and p_3, length	5 (4.8)
P_3, antero-posterior diameter	7
P_3, transverse diameter	3
P_4, antero-posterior diameter	7
P_4, transverse diameter	4
Molar series, length	28 (27.5)
M_1, antero-posterior diameter	6
M_1, transverse diameter	5
M_2, antero-posterior diameter	9
M_2, transverse diameter	6
M_3, antero-posterior diameter	13
M_3, transverse diameter	5
Depth of jaw at p_2	5.7
Depth of jaw at m_2	10 (12) *

* This dimension probably makes allowance for the abraded ventral surface of the jaw.

Horizon: ? Uppermost Duchesne River: "From the Uinta beds (Diplacodon zone of the Beaver Divide)," Granger.

Locality: "Near Hailey, Wyoming."

POABROMYLUS Peterson

Poabromylus Peterson, *Ann. Carnegie Mus.* **21**: 75, 1931.

Peterson's description reads:

Generic Characters: Jaw slender; P_2, P_3, and P_4 of semi-equal length, as in *Poëbrotherium wilsoni*. P_3 and $_4$ relatively shorter and thicker; protoconid rounder and higher, and the basal accessories less distinct than in *Poëbrotherium*. There is a diastema in front of P_2, as in *Poëbrotherium wilsoni*. The molars are relatively shorter and less hypsodont than in *Poëbrotherium*. Animal nearly the size of *Poëbrotherium wilsoni*.

The diastema in front of P_2 is of considerable length (8 mm. from P_2 to where the jaw is broken). As already stated P_2 is close to P_3, the tooth was implanted by two roots, the alveoli of which are directly antero-posterior, indicating an antero-posterior diameter approximately equal to either of the posterior premolars. The protoconid of P_3 is rather high and terminates in a round pointed apex. The internal face of the main cusp (protoconid) has near its posterior base a cusp-like rib closely adhering to the main body of the protoconid. Together with the external body of the heel this rib on P_3 helps form a fossa which is open behind. Forward and inward from the protoconid there extends a sharp blade-like tubercle, which likewise helps to form a vertical shallow groove on the inner face of that portion of P_3, not unlike that in *Poëbrotherium*. P_4 is very similar to P_3, except that the posterior heel in P_4 is more pronounced, the plate-like tubercle on the inner face of the protoconid is slightly better indicated, and the anterior blade-like tubercle heavier. Altogether the premolars in *Poabromylus* are less trenchant than in *Poëbrotherium*.

The molars are narrow when compared with the known selenodonts of the Upper Eocene, with the possible exception of *Leptotragulus*. On the whole the molars as well as the two premolars just described, are most nearly like those of *Poëbrotherium wilsoni* of the White River Oligocene, though less hypsodont. The lingual face of M_2 and

part of that of M_3 are destroyed, but enough remains to determine that, though the inner face of the molars have [*sic*] the vertical grooves and ridges more pronounced than in *Poëbrotherium*, they are on the whole most nearly comparable to those in that genus. A cingulum between the crescents on the external face of the molars is slightly indicated, especially on the first and second molars. The heel of M_3 is fully as large proportionally as that in *Poëbrotherium wilsoni*, but the pillar on the inner face at the junction with the postero-internal crescent in *Poëbrotherium* is in the present form represented only by a tubercle, as in *Leptotragulus* of the Uinta.

The proposed genus, just described, differs from "*Leptotragulus*" *profectus* Matthew (Bull. Amer. Mus. Nat. Hist., 1903, p. 224) by having the posterior internal crests of the premolars less developed and the anterior crests less pronounced. Judging from Matthew's illustration (*l. c.*) of the lower jaw, P_2 in "*Leptotragulus*" *profectus* is very probably a smaller tooth than that in *Poabromylus kayi* by having a diastema between P_2 and P_3, heavier heels, and the protoconid more nearly in the midbody of the premolars, and by a more complicated fifth lobe of M_3.

The proposed new genus *Poabromylus* is distinctly farther advanced than *Eotylopus reedi* from the Lower Oligocene of Wyoming and apparently cannot therefore be regarded as holding an intermediate position between *Protylopus* of the Uinta and *Poëbrotherium* of the White River Oligocene. The late Dr. Matthew has pointed out that *Eotylopus* stands closer to *Protylopus* of the Uinta Eocene than to *Poëbrotherium* of the Eastern Oligocene. From present evidence *Poabromylus* certainly stands closer to *Poëbrotherium* than to *Protylopus*.

No addition to Mr. Peterson's description is necessary, except to emphasize the distinction between *Poabromylus* Peterson and *Camelodon* Granger. The latter is the more specialized, as is shown in the conspicuous diastema between p_2 and p_3 and in the complication of the fifth lobe of m_3. It is unfortunate that in the type and only known specimen of *Camelodon* the molars are so worn as to make the cuspidation unrecognizable, but even in this unsatisfactory condition, the advanced specialization is plain and supports the reference, as here made, to a post-Uinta date.

There is considerable doubt and confusion concerning the phylogeny of the camels in Oligocene times, the difficulty being due to an *embarras de richesses* of the material at hand. The most ancient known member of the Camelidae is *Protylopus*, which is the only genus of the family yet found in the Uinta. In *Protylopus* the lower teeth form a continuous series, without diastemata; the upper teeth are more widely spaced, to permit the occlusion of the inferior premolars and canines. In the Duchesne River, we find *Poabromylus*, without diastemata, and *Camelodon*, in which there is a considerable space between p_2 and p_3. In the lower White River, the most ancient species of the commonest White River genus, *Poëbrotherium*, *P. eximium*, the spacing of the lower teeth is nearly the same as in *Protylopus*, but in the subsequent *P. wilsoni* and *P. labiatum* p^2 is isolated by considerable diastemata. As usually interpreted, the *law of orthogenesis would exclude Camelodon from the ancestry of Poëbrotherium*, for *P. eximium*, indubitably a member of the genus, retains the continuous arrangement of the lower teeth which characterizes the Eocene *Protylopus*. In a study recently made of the phylogeny of the horses and camels,[25] I found strong reasons to believe that in the anterior teeth, incisors, canines and premolars of both of these groups, there was much fluctuation and even reversal of development. If this conclusion is substantiated, the ancestral line of the camels may include *Camelodon* as well as *Poabromylus* and *Poëbrotherium eximium*.

Poabromylus kayi Peterson

Poabromylus kayi Peterson, *Ann. Carnegie Mus.* **21**: 75, 1931.

As but one species is known, the dimensions make a sufficient diagnosis. I have verified Peterson's figures, which, in the subjoined table, are put in parentheses, making a few changes, and have also added the measurements of a second specimen, of which only the lower molars are preserved.

MEASUREMENTS

	C. M. No. 11,856	*C. M. No. 11,753*
Total length of the jaw-fragment		75 (80) mm.
Depth of ramus at posterior part of symphysis		10
Depth of ramus beneath m_3 (est.)		18
P_3, antero-posterior diameter		8.5
P_3, greatest width		3.5 (3)
P_4, antero-posterior diameter		8
P_4, greatest width		5 (4)
Lower molar series, length	30 mm.	35
M_1, antero-posterior diameter	9	9 (9.5)
M_1, greatest width	8	6
M_2, antero-posterior diameter	8.5	11
M_2, greatest width	8	8 (8 approx.)
M_3, length	14	16 (21)
M_3, width of anterior crescent	8	9 (7)
M_3, width of posterior crescent	7	8
M_3, width of heel	4	5

Horizon: Duchesne River, Lapoint substage.
Locality: type, No. 11,753, 200 feet N. of *Teleodus* Quarry; No. 11,856, Uinta Co., Utah, near head of Halfway Hollow.

FAMILY ?**HYPERTRAGULIDAE** COPE

The materials which are supposedly referable to this family, so far found in the Duchesne River beds, are very rare and very fragmentary, even in this scanty fauna. Peterson listed a ?*Leptomeryx minutus*, of which the identification is extremely doubtful. The fossil here attributed to a hypertragulid *inc. sed.* is a jaw-fragment with three teeth which are selenodont, but so tiny, that analysis is very difficult. As these teeth are low-crowned, they cannot have belonged to *Hypisodus*, though they may indicate some ancestor of that genus. However, this is entirely conjectural and of small interest. Another individual, of a much

[25] Scott, W. B., *Trans. Amer. Philos. Soc.* **28**: 951, 1941.

larger animal, described below, is more significant, though of uncertain reference.

?Hypertragulid incertae sedis

(Pl. II, fig. 3)

The specimen in question is the fragment of a palate, with teeth on both sides; (C. M., No. 10,199) on the left are three teeth, p^3, p^4, and m^1, on the right the same two premolars. The third premolar is a sharp-pointed, compressed-conical tooth, with a prominent median rib on the buccal face and, on the lingual side, a strong cingulum, which thickens to a small cusp on the postero-internal angle; this cusp is carried on a separate, third root. P^4 is the usual bicrescentic tooth, so general among selenodonts; on the buccal face there are a median rib, a strong metastyle and much less distinct parastyle. The protocone is conical rather than crescentic, but the deuterocone is a very complete crescent, the horns of which reach the outer wall, embracing the protocone; the cingulum is prominent on the lingual face.

The first molar is very wide transversely, short antero-posteriorly and curiously asymmetrical, owing to the greater breadth of the anterior half of the crown; the external crescents have prominent median ribs and the para- and mesostyles are relatively large, but there is no metastyle. The antero-internal crescent is considerably larger than the postero-internal and the valley separating it from the outer cusp is notably wider than that separating the two posterior crescents, internal and external. The width of the anterior half of the crown is increased by the heavy internal cingulum, which surrounds the inner crescent and gives to the tooth an appearance of having three anterior cusps arranged in a transverse line, but none of these is a true conule. The hypocone is distinctly smaller than the protocone and its cingulum is much less prominent, except in the transverse valley, at the entrance of which it forms a pillar.

This tooth is distinctly quadritubercular in contradistinction from the quinque-tuberculate upper molars which characterize the upper molars of the oreodonts, agriochoerids and other Uinta selenodonts, except the Camelidae and Hypertragulidae. It is this feature which has occasioned the reference of the specimen to the hypertragulids.

MEASUREMENTS

P^3, antero-posterior diameter	6 mm.
P^3, transverse diameter	4
P^4, antero-posterior diameter	6
P^4, transverse diameter	8
M^1, antero-posterior diameter	7
M^1, transverse diameter (anterior half)	10
M^1, transverse diameter (posterior half)	9

Horizon: Duchesne River, Lapoint substage.
Locality: 2 miles N.E. of Randlett, Uinta Co., Utah.

FAMILY **?LEPTOMERYCIDAE** OSBORN

?LEPTOMERYX LEIDY

?Leptomeryx minutus Peterson

?*Leptomeryx minutus* Peterson, *Ann. Carnegie Mus.* **21**: 75, 386, 1931.

Under this term Peterson described a fragment of the right mandibular ramus of an extremely small selenodont artiodactyl, belonging, presumably, to this group, but entirely insufficient for any definitive reference. The typical specimen is a fragment of the lower jaw, containing three teeth, p_4, m_1 and m_2, in a well worn condition, though hardly to be called old. (C.M. No. 11,913) Peterson's description will suffice and it is, therefore, reproduced here.

Specific characters: The apices of proto- and deuteroconids of P_4 more completely separated and the postero-internal tubercle of less development than in the eastern forms (i. e. in South Dakota), while the antero-internal body of the tooth is nearly equally developed to that of other species. The molars appear to be equally hypsodont to those in the known species, the exit of the external cross-valley is also more solidly filled as in some forms of *Leptomeryx* [*L.* (?) *evansi*] and less styliform than in *Leptotragulus*, while the styloid-like cingulum on the antero-internal angle of M_2 is present as in *Leptotragulus*; absent in *Leptomeryx*. The specimen from the Duchesne River Oligocene is smaller than any hypertragulid heretofore discovered in the eastern Oligocene or in the Uinta Eocene.

MEASUREMENTS

Length P_4-M_2	13 mm.
Length P_4	4
Transverse diameter M_1	3
Length of M_1	4
Length of M_2	4.5
Transverse diameter of M_2	3

Horizon: Duchesne River Oligocene.
Locality: "North side of 'Red Narrows,' east of Tridell, Uinta County, Utah."

SUPERFAMILY **OREODONTOIDEA** GILL, 1872

Agriochoeroidae Hay, 1929
Merycoidodontoidea Thorpe, 1937

Whatever value the evidence may have, the most striking difference, on the face of that evidence, between the Uinta and the Duchesne River faunas is that, in the former, there is a great abundance of the family Merycoidodontidae, most representatives of which belong to the genus *Protoreodon*, while in the latter, they are relatively very rare. Making all due allowance for the extreme scarcity of Duchesne River fossils of all sorts, it seems unlikely that this difference is without meaning and due entirely to the accidents of collecting. The comparative rarity of merycoidodonts persists throughout the Chadron substage of the White River, but again gives place to an extraordinary abundance in the succeeding Brulé substage. The Agriochoeridae, on the other hand, are much better represented and are relatively more important than

in any subsequent geological stage. In such an impoverished fauna, however, statistics are of little importance.

Of the Duchesne River agriochoerids, Peterson says:

> From the mutilated skulls and jaws, as well as limb-bones, few important characters are obtained, but the detailed structure of the dentition affords nearly everything desired in the way of forms in the line to the Agriochoerids of the White River, John Day and other Oligocene deposits, while *Diplobunops* from the Uinta (Horizon C) . . . apparently represents a subfamily. The robustness of the premolar teeth, especially those anterior, in the latter genus is well marked when compared with those teeth in the new material noted in the following discussion. The step toward the molarization of P 4/4 in the new material is clearly an advance beyond *Protagriochoerus* and it is certainly a great advance upon that of *Diplobunops* when the similarities in the appendicular structure in the latter genus and *Agriochoerus* are considered.[26]

Family **AGRIOCHOERIDAE** Leidy

MESAGRIOCHOERUS Peterson

Mesagriochoerus Peterson, *Ann. Carnegie Mus.* **23**: 377, 1934.

Principal Characters: $I\frac{3}{3}$, $C\frac{1}{1}$, $P\frac{4}{4}$, $M\frac{3}{3}$. P^1 two-rooted and crown laterally compressed. P^2 similar to P^1, but with posterior portion of greater transverse diameter. P^3 with a distinct deuterocone, placed well back, as well as a slight cingulum on the posterior face. P^4 with the apex of the protocone twinned and the initial step taken toward the postero-internal crescent. M^1 and M^2 with weak protoconule, while M^3 has little or no indication of such. P_1 with high, trenchant and caniniform crown characteristic of the group; P_2–P_3 with laterally compressed and simple crowns; P_4 with undeveloped deuteroconid, broad heel and the antero-internal body of the crown well indicated. Lower molars relatively long and narrow, limb bones slender when compared with those of *Diplobunops*. In size the animals range between *Protoreodon medius* and *P. parvus*.

The premaxillary is of fair proportionate size and in its alveolar border are inserted the roots of three incisors of nearly subequal size. The muzzle and facial region when compared with that of *Protoreodon* may be considered as medium long. There is a short diastema between canine and P^1 as in *Protagriochoerus*. The molar of the material under study perhaps suggests most nearly that of *Protagriochoerus;* it has not the abrupt lateral expansion seen in *Agriochoerus*, but the postorbital process is proportionally as robust, as is also the postorbital process of the frontal. The rather small and round orbit is, however, widely open posteriorly as in *Protagriochoerus* and later forms. The height of the alveolar border of the maxillary is relatively equal to that in *Agriochoerus* and the infraorbital foramen appears to be similarly located (above P^3).

As already stated, there are three incisors of approximately subequal size. The canine is well proportioned and of the characteristically D-shaped cross-section. $P\frac{1}{1}$ following the canine after a short diastema, has a simple crown, secant, laterally compressed, with an antero-posterior diameter somewhat less than in *Protagriochoerus*, but relatively greater than that in *Agriochoerus* in which P^1 is much reduced. The crown of P^2 is equally as sharp-pointed as that of P^1 but is of somewhat greater transverse diameter and has a prominent basal cingulum on the postero-internal angle, but not what can be regarded as a deuterocone. P^3 has a deuterocone fairly well defined, a weak antero-internal cingulum, and the indication of a vertical rib at the posterior part on the internal face of the protocone like the corresponding one in *Agriochoerus* which is, however, of greater prominence in the genus of the White River Oligocene. The latter genus also has the cingulum more strongly developed on the posterior face of P^3 and therefore the initiative step towards the development of a tetartocone or posterior inner crescent is more clearly before us. The most interesting and extraordinary feature in the genus here proposed is the stage in the development of p^4. The two distinct vertical ribs or styles on the internal face of the protocone of P^4 in *Protagriochoerus* heretofore overlooked by students, have in the present genus advanced farther. In the unworn tooth the apex of the protocone has reached the twinning stage, somewhat analogous to what we find in the molars of *Deltatherioides* and *Zalambdalestes* from the Mongolian Cretaceous described by Gregory and Simpson. . . . This structure of P^4 in our present specimen is so plainly evident that there can be no question as to the subsequent division of this tubercle into the proto- and tritocone, a step still further advanced in *Agriochoerus minimus* Douglass from the Thompson Creek Oligocene of Montana and completely effected in the agriochoerids of the White River Oligocene of Dakota. On the posterior horn of the deuterocone crescent of P^4 in our new material there is a distinct vertical style which cannot be regarded as anything but the initial rudiment of the postero-internal crescent again slightly advanced in *Agriochoerus minimus* and which, though small, is completely developed in the White River forms. The antero-external style of P^4 in the present genus is of greater prominence than in the White River representatives and suggests more closely that in *A. minimus*.[27]

The protoconules of M^1 and M^2 are reduced and that of M^3 slightly indicated or entirely absent. The para- and mesostyles in our specimen are reduced in size and the cingulum between them less firmly connected when compared with *Protagriochoerus* and *Diplobunops* from the upper Eocene, but the styles have not reached the sessile position and are not as gently rounded in shape as those in *Agriochoerus*, nor does the cross-valley between para- and metacone extend as far outward as in the latter genus, especially on M^1 and M^2. The lingual faces of the internal tubercles are also more sharply rounded than in *Agriochoerus*.

The ramus of the lower jaw is deep, thin, and the symphysis is long and robust. The second and third lower incisors, with slightly expanded crowns, are yet adhering to the front of the lower jaws and the median tooth was undoubtedly present. Though incisiform, the lower canine is slightly larger than the true incisors. P_1 has the characteristically high, sharply pointed and laterally compressed crown. There is a very slight diastema between the first and second premolars. P_2 is of relatively greater antero-posterior extent when compared with that of *Agriochoerus* and is also more compressed laterally. P_3 is much like P_2 except that it has a greater transverse diameter posteriorly. The primary tubercle (protoconid of P_4) is well developed and rises well above the rest of the crown; the metaconid though low, is distinctly formed, while the apex of the deuteroconid cannot be said to be entirely isolated from the internal face of the protoconid as is the case in *Agriochoerus*. The anterior crest of the protoconid appears to be almost as far along in its development as it is in *Agriochoerus*, while postero-internally there is yet no indication of a tubercle; in *Agriochoerus*, on the other hand, P_4 is completely molariform, plus the anterior crest of the trito-

[26] Peterson, O. A., *Ann. Carnegie Mus.* **23**: 377, 1934.

[27] *Ibid.*: 377 ff.

conid which was already developed before the quadritubercular structure of the tooth took place.

The lower molars are relatively long and narrow when compared with those of *Agriochoerus*. The basal styles on the lingual face of the molars, though already indicated are not as well developed as in the genus from the White River Oligocene. The heel of M_3 is of an equal proportionate length, but narrower than that in *Agriochoerus*.[28]

In comparing *Mesagriochoerus* with *Protagriochoerus*, it is at once observed that the latter genus is slightly over one-fifth larger, and P^4 not nearly as far along with regard to its indication of its molariform structure as that in *Mesagriochoerus*. While the general detailed structure of the molars is very similar, the protoconule in the species under description [i. e. *Mesagriochoerus primus*] is considerably less developed. The two genera here compared are quite similar and it seems quite probable that *Protagriochoerus* stands ancestral to *Mesagriochoerus*.[29]

In the Carnegie Museum there is a skull, with separate lower jaw (C.M. No. 12,080) collected after the publication of the paper just cited and (indeed, after Mr. Peterson's death) which is very much more complete than the holotype. It is, however, slightly distorted and largely covered by an extremely hard incrustation, which contains much hematite. This skull may be taken as the basis of a description more detailed than was possible from the original material.

DENTITION

The number of incisors cannot be determined from No. 12,080, but Peterson gave the formula as unreduced: $i\frac{3}{3}$, $c\frac{1}{1}$, $p\frac{4}{4}$, $m\frac{3}{3}$.

Upper Teeth.—The broken stumps of some *incisors* remain in the premaxillae and these are relatively larger than in *Agriochoerus* and the canine has the D-shaped cross-section that characterizes the oreodont superfamily, but is decidedly slender. This slenderness may, however, be sexual rather than specific. One of the most striking differences between the Duchesne and the White River genera is that, in the former, the tooth-rows are continuous and without diastemata, other than the narrow space into which the lower tusk (p_1) occluded. In this respect, *Protagriochoerus* and *Mesagriochoerus* agree with the merycoidodont family. In *Agriochoerus*, on the other hand, there are considerable diastemata between tusks and cheek-teeth, above and below, which is a departure from all the preceding members of the superfamily, save the aberrant *Diplobunops*.

The *premolars* are of especial interest, as being intermediate between those of the Uinta and those of the White River genus, a fact which Peterson emphasized by his choice of a name for the Duchesne River form. These teeth increase in size and complexity posteriorly, except that p^3 has a broader buccal face than have the teeth in front of and behind it. On the external side, the four premolars look much alike, compressed-conical and trenchant, with sharp edges and acute apices and having, in Leidy's phrase, cordate outlines; none of them has any basal cusps, or tubercles, anterior or posterior. Internally, however, matters are very different; p^1 is quite simple, with no cusps on the lingual face; p^2 is simple, except for two minute enamel pockets internally. P^1 and p^2 are each implanted by two roots, p^3 and p^4 by three, an inner root being added; p^3 has a distinct deuterocone, from which a ridge runs backward and outward to the external wall, enclosing a deep and relatively large enamel pocket; p^4 has the form usual among selenodonts, of two transversely placed crescents, but, as Peterson pointed out, the protocone has a twinned appearance, owing to the presence of an incipient deuterocone. Peterson also called attention to the existence of two "distinct vertical ribs, or styles on the internal face of the protocone," which occur in *Protagriochoerus* and are larger in *Mesagriochoerus*, and to the vertical style on the posterior horn of the inner crescent.

The *molars* are likewise of much interest, because of a character which is intermediate between the tooth pattern of *Agriochoerus* and that of *Protagriochoerus*, of the Uinta, the upper molars of the latter being much nearer to those of *Protoreodon*. Of the three molars, the first is decidedly the smallest and the third somewhat the largest; they retain, but in much reduced condition, the anterior intermediate cusps, or protoconules. The external crescents are distinctly more like those of *Agriochoerus*, especially those of m^3, in being more concave, in having more prominent external styles, especially on m^3, in which the mesostyle clearly approximates that of the latter genus in its rounded, bulbous form, the transverse valley extending into it and separating the adjacent horns of the outer crescents, while in m^1 and m^2 these horns are connected, as they are in *Protagriochoerus*, in which all three molars are alike in the junction of the external crescents. The internal crescents are very wide and low and have a decided resemblance to those of *Agriochoerus*.

Lower Teeth.—The *incisors* are small, with narrow roots and broadened crowns; the *canine* is like an incisor in form and function and appears to be one of that series, as in the Pecora. The *premolars* have the same transitional character as those of the upper jaw, between the Uinta and White River members of the family. P_1 is, of course, the functional canine, as is well-nigh universal throughout the superfamily, but is, like the upper canine, slender and compressed, again perhaps, a sexual feature; p_2 is a compressed and trenchant cone, without complications. P_3 is similar externally, but lower and more elongate antero-posteriorly; internally, this tooth differs slightly in the two specimens; in the type there is a minute deuteroconid and a very low ridge of enamel below it, but in No. 12,080 there is no distinct deuteroconid but a ridge parallel to the protoconid and enclosing with it a nar-

[28] *Ibid.*: 381.
[29] *Ibid.*: 384.

row enamel pocket. P_4 is evidently beginning to take on the molar pattern, which is fully attained in *Agriochoerus*, a feature that is very rare among artiodactyls. Again, there is a small difference between the two individuals, which is probably due to wear; in the unworn tooth there is a large deuteroconid, which rises almost as high as the principal cusp; there are also a distinct, basin-like heel and an anterior basal cusp. In the worn tooth the same elements may be detected, but they are somewhat obscured.

The lower *molars*, as Peterson noted, are narrow and elongated from before backward and are progressively larger posteriorly; they have a distinct resemblance to the corresponding teeth of *Agriochoerus*, but are relatively narrower and the longitudinal valley, between internal and external crescents, is also narrower; the inner cusps are thin plates rather than crescents. The heel of m_3 is large.

In the American Museum is a second individual from the Beaver Divide, Wyoming, which is presumably referable to this genus, though, for lack of m_3, the reference is not altogether certain. The fossil consists of the incomplete facial portion of a skull, with three teeth, dp^4, m^1 and m^2, on the left side, m^1 and m^2 and the unerupted anterior half of m^3, still in the alveolus, on the right. There is also part of the right ramus of the mandible containing dp_3, dp_4, m_1 and m_2. For the opportunity to describe this interesting fossil, I am indebted to the kindness of Dr. G. G. Simpson.

Milk Teeth.—In the upper jaw the only temporary tooth preserved is dp_4, which may be briefly dismissed, for it is completely molariform, though much smaller than any of the molars, and the protoconule is less reduced.

In the lower jaw, as mentioned above, dp_3 and dp_4 are preserved; dp_3 is of compressed-conical shape and somewhat peculiar. The free, cutting edge of the crown is considerably worn both in front and behind, though the apex remains acutely pointed, and the antero-internal valley is almost obliterated. There is a minute, but distinct deuteroconid, which has an enamel pocket on its hinder side. Seen from the buccal side, this tooth appears to be quite simple, as the incipient complications are confined to the lingual face.

The hindmost of the milk-premolars, dp_4, has the three pairs of cusps, universal among artiodactyls; the anterior pair of crescents are the smallest, the posterior pair the largest and the middle pair intermediate in size as well as position. Aside from the additional pair of cusps the tooth is smaller than m_1, but has the molar pattern. There is a prominent inner cingulum and a minute pillar between the first and second internal crescents.

SKULL

In both individuals the skull is badly damaged by crushing and largely hidden under ferruginous incrustation, but its outline may be discerned. Mr. Horsfall's drawings (pl. III) skillfully compensate these deficiencies and present the skull as it must have appeared before fossilization. It differs from the skull of *Agriochoerus* in the relatively shorter face and longer cranium and in the absence of diastemata from the dentition. The orbit is more widely open behind, because of the shorter postorbital processes, though these are already distinct, above and below. The zygomatic arches are much alike in the two genera, but the flat suborbital portion of the jugal is narrower in *Mesagriochoerus* and the whole arch relatively less robust. The bony palate is moderately concave transversely and broadens posteriorly because of the divergent tooth-rows, and the posterior nares extend forward between the first molars. The brain case is much crushed, but appears to be less capacious than in *Agriochoerus*.

The series *Protagriochoerus-Mesagriochoerus-Agriochoerus*, well-nigh demonstrates the common origin of the two families included in the Oreodontoidea, the Merycoidodontidae and the Agriochoeridae and, if this inference be accepted, it follows that the undoubted likeness of the molars of *Agriochoerus* to those of the bothriodonts is one of the many instances of convergent development, for which there is such strong evidence.

Those who have accepted Schlosser's suggestion that the agriochoerids were nearly related to the anthracotheres, have always ignored the merycoidodonts and yet their deer-like, or camel-like molars must be taken into account. There are several possible interpretations of the evidence, as it stands: (1) That the two families are entirely unrelated and that the many resemblances between them, including the most exceptional character of the caniniform first lower premolar, are all due to convergence; (2) that the two families are nearly related, but that one of them has convergently developed a molar pattern, the other changing little from the ancestral type of dentition; (3) that both families have acquired different molar-plans, convergently, one to the anthracotheres the other to the selenodonts.

The fossils of the Uinta and Duchesne River formations strongly support the second of these alternatives; the contemporary Uinta genera *Protoreodon* and *Protagriochoerus* are very closely related and there is little difference in molar teeth between them, yet in the Duchesne River genus, *Mesagriochoerus*, the separation is already distinct and the approximation to the White River *Agriochoerus* is unmistakable. Either one or the other of the two families must have developed a molar pattern convergently and, in view of the connecting series above described, it is far more probable that the convergently developed dentition is that of the agriochoerids. Unfortunately, the ungual phalanges are not known in the Uinta *Protagriochoerus* but in the allied, though aberrant *Diplobunops*,

the unguals are claw-like. In *Protoreodon* of the Uinta the unguals are longer, narrower, more pointed and altogether more claw-like than in the succeeding merycoidodonts of the White River.

If these conclusions are well founded, it follows that the likeness of the upper molars of *Agriochoerus* to those of the anthracotheres—a likeness to which attention has repeatedly been directed—is not due to any close relationship between the groups, but has been independently acquired. The molars of *Protagriochoerus*, despite the presence of the fifth cusp (protoconule) are less like those of *Ancodus* [= *Bothriodon*] than are the molars of its White River successor.[30]

Mesagriochoerus primus Peterson

Mesagriochoerus primus Peterson, *Ann. Carnegie Mus.* **23**: 377, 1934.

The two available specimens of this species (Carn. Mus., Nos. 11,893, and 12,080; the former is the type specimen) were found in the same horizon of the Duchesne River beds, the Randlett, and the minute differences between their premolars are unimportant; in size, they are almost identical. A third individual, from the Beaver Divide, Wyoming, presumably referable to the same species, is in the collection of the American Museum of Natural History, No. 22,558.

MEASUREMENTS

	C.M. No. 11,893	*C.M. No. 12,080*	*A.M.N.H. No. 22,538*
Upper dentition, length, c–m^3	75 mm.	68 mm.	
Upper canine, antero-posterior diameter	6	6	
Upper cheek-tooth series, length	66	68	
Upper premolar series, length	32	32	
Upper molar series, length	35	32	
P^1, antero-posterior diameter	6	7	
P^1, transverse diameter	2	4	
P^2, antero-posterior diameter	9	8	
P^2, transverse diameter	3	4.5	
P^3, antero-posterior diameter	9	7	
P^3, transverse diameter	6	8	
P^4, antero-posterior diameter	9	7	
P^4, transverse diameter	9	9	
Dp^4 antero-posterior diameter			9 mm.
Dp^4, transverse diameter			9.5
M^1, antero-posterior diameter	10	10	10
M^1, transverse diameter	10	10	11.5
M^2, antero-posterior diameter	11	12	11
M^2, transverse diameter	12	13	13
M^3, antero-posterior diameter	12	12.5	
M^3, transverse diameter	13	13	
Lower dentition, length c–m_3		77	
Lower premolar series, length	33	34	
Lower molar series, length		38	
P_1, antero-posterior diameter	7	6	
P_1, transverse diameter	4		
P_2, antero-posterior diameter	7	7	
P_2, transverse diameter	3	4	
P_3, antero-posterior diameter	7.5	7.5	
P_3, transverse diameter	4	4.5	
P_4, antero-posterior diameter	9 mm.	9 mm.	
P_4, transverse diameter	5	5	
Dp_3 antero-posterior diameter			7 mm.
Dp_3, transverse diameter			4
Dp_4, antero-posterior diameter			10
Dp_4, transverse diameter			5
M_1, antero-posterior diameter	9	9.5	8
M_1, transverse diameter	6.5	7	7
M_2, antero-posterior diameter	10	11	10
M_2, transverse diameter	7	8	8
M_3, antero-posterior diameter		17	
M_3, transverse diameter		8	

Horizon: Duchesne River, Randlett substage.
Localities: Type, No. 11,893, Randlett Point; No. 12,080, 1 mile S. of Baser Bend, Uinta Co., Utah; No. 22,558, A.M.N.H., Beaver Divide, Lander, Wyo.

DIPLOBUNOPS PETERSON

Diplobunops Peterson, *Ann. Carnegie Mus.* **12**: 76, 1919.

The detailed description of this genus is deferred until publication of Part II of this monograph, which is to deal with the mammalian fauna of the Uinta age, because the material of the Uinta species is incomparably more complete than of those found in the Duchesne River beds. In the Carnegie Museum the type and paratype specimens of *D. uintensis* and *D. ultimus* afford material for the assembling of a nearly complete skeleton and even more perfect is a skeleton in the Princeton collection. The genus also occurs in the Duchesne River, where it is represented by a distinct species, *D. crassus* sp. nov., which is described below. The type of the genus was so very fragmentary that Peterson was misled into referring it to the European anoplotheres, comparing it especially with *Diplobune quercyi*. The name which he gave to his new genus, *Diplobunops*, shows his belief as to its relationships. The original generic description (1914) was drawn entirely from the limb-bones, for, in neither type nor paratype were there any complete upper teeth preserved, but, at a much later date (1931), after the discovery of the skeletons now in the Carnegie Museum, Peterson published an emended diagnosis, which is repeated below, when he had learned that the reference of *Diplobunops* to the anopolotheres was a mistake and had transferred it to the Agriochoeridae.

Generic characters: . . .
P^1 isolated by well defined diastemata; P^3 without distinct deuterocone, but with a heavy internal mass supported by a strong root. P^4 with well developed deuterocone. Molars with anterior intermediate tubercles. Short and stout limbs; short and broad feet with high and laterally compressed unguals.[31]

It should be added that the molar teeth have much resemblance to those of *Agriochoerus*, more so, in fact, than do those of *Protagriochoerus* of the Uinta, but are relatively narrower, and the external crescents are less extended across the crown than in the White River genus.[32]

[30] Scott, W. B., *Trans. Wagner Free Inst. Sci. Phila.* **6**: 110, 1899.

[31] Peterson, O. A., *Ann. Carnegie Mus.* **20**: 342, 1931.

[32] Scott, W. B., *Trans. Amer. Philos. Soc.* **28**: pl. 77, fig. 1, 1940.

So far as is known, *Diplobunops* is confined to the Duchesne River and the Myton substage of the Uinta (Horizon C) but, in all probability, some forerunner must have existed in the earlier Uinta.

Peterson named three species of *Diplobunops*, each at a different level in the Uinta beds: *D. matthewi* occurs near the base of the Myton; *D. uintensis* was found 250 feet above the base of the Myton and *D. ultimus* 150 feet above *D. uintensis*. *D. leotensis* [33] is very probably meant to apply to a fragmentary skeleton found "near the base of the Duchesne Oligocene, three miles north of Leota Ranch," though the author does not say so, and I can find no other mention of this species, of which no definition is given and which is plainly a *nomen nudum*. It may, however, be a synonym of *D. ultimus* Peterson q.v.

Diplobunops crassus sp. nov.

?*Diplobunops sp.* Peterson: *Ann. Carnegie Mus.* **21**: 74, 1931.
?*Diplobunops leotensis: nomen nudum, Ann. Carnegie Mus.* **21**: 74, 1931

The type specimen of this species is a skull, without mandible, in the Carnegie Museum (No. 2967) which is uncommonly complete and free from distortion for a Duchesne River fossil, though it is much cracked, covered with an incrustation and somewhat downcrushed; in consequence, few of the sutures are visible. Mr. Peterson died in November 1933 and appears never to have seen this skull, or the two referred specimens, Nos. 11,301 and 11,769. As the detailed description of the skull in this genus is expected to follow in Part II of this monograph, which is to deal with the Uinta fauna, it will be necessary, at this point, merely to enumerate the specific characters.

The only Duchesne River fossils which Peterson provisionally assigned to the present genus were an upper molar and the fragmentary skeleton above referred to. Of the isolated tooth he says:

> An upper molar tooth, C.M. No. 11,853, . . . is provisionally placed in the genus *Diplobunops*. My principal reason for doing this is the presence of the vestigial protoconule on the crown of the tooth, the poorly developed posterior horns of proto- and hypocones and the heavy and obliquely backward directed parastyle, as in the Eocene Oreodonts in general. That the tooth may pertain to a distinct new genus is entirely probable, but I prefer to wait until a more complete specimen is found before adding another genus from this new horizon.

Of the skeletal fragments, he writes:

> The fragments of the upper teeth indicate an animal the size of *Diplobunops uintensis*. The humerus, femur, and tibia appear to be proportionally lighter and the cnemial crest of the tibia not extending so low as in *Diplobunops*. The astragalus, on the other hand, is low and broad, as in the latter genus. The distal articulation of Mt. IV is not hemispherical on the dorsal face, as it is in *Diplobunops*, but more nearly like that in *Merycoidodon*. The two terminal phalanges present are not high, narrow and claw-like, as in *Diplobunops*, nor as much depressed, though fully as broad as in *Merycoidodon*. The lateral borders of the anterior half of the ungual is [*sic*] expanded near the plantar face, giving the bone a unique appearance. If this specimen pertains to one individual, the combination of the characters noted would certainly indicate a distinct species of the genus *Diplobunops*, if not a distinct genus, nearly allied to the latter. The material is, however, in my judgment, unsatisfactory to serve as a type.[34]

In the doubt concerning the provenance of this material and whether it was derived from more than one individual, any discussion of it would be unprofitable, further than to say that the metatarsal and ungual phalanges cannot have belonged to any species of *Diplobunops*.

The Carnegie Museum skull, which is the type specimen of *Diplobunops crassus*, differs from those of the Uinta species in several conspicuous respects and the enumeration of these differences may serve as a diagnosis of *D. crassus*.

(1) The skull, while nearly of the same length as that of *D. uintensis*, is considerably broader and more massive.

(2) The postorbital constriction is decidedly shallower, making the cranium much broader at this point.

(3) The nasal bones are relatively broader.

(4) The postorbital process of the jugal is much longer and more prominent.

(5) The diastema between the canine and p^2 is longer.

(6) On p^3 the deuterocone is smaller.

(7) On the upper molars the antero-intermediate cusp (protoconule) is much reduced, hardly more than vestigial, a fact which Peterson notes for the isolated upper molar from the Duchesne River beds, which he figured.

(8) The parastyle of m^3 is larger, making the anterior half of the crown relatively wider, while the postero-internal crescent (hypocone) is reduced.

(9) The general aspect of the upper tooth-row is distinctive, but in a way that is difficult to describe.

MEASUREMENTS

	C. M. No. 2,967	*C. M. No. 11,769*	*C. M. No. 11,301*
Upper dentition, length c–m^3 incl.	110 mm.		
Upper cheek-tooth series, length	92.5		
Upper premolar series, length*	41		
Upper molar series, length*	45	37 mm.	40 mm.
P^1, antero-posterior diameter	9.5		
P^1, transverse diameter	5		
P^2, antero-posterior diameter	10		
P^2, transverse diameter	5		
P^3, antero-posterior diameter	11		
P^3, transverse diameter	12		
P^4, antero-posterior diameter	11		
P^4, transverse diameter	14.5		
M^1, antero-posterior diameter	15	11	13

[33] Peterson, O. A., *op. cit.* **21**: 74, 1931.

[34] *Ibid.*: 74–75.

M^1, transverse diameter	17 mm.	15 mm.	14 mm.
M^2, antero-posterior diameter	17	12	13
M^2, transverse diameter	20	18	15
M^3, antero-posterior diameter	17.5	14	15
M^3, transverse diameter anterior half	22.5	21	18
M^3, transverse diameter posterior half	15		
Skull, length prmx. to occ. cond.	203		
Skull, width over zyg. arches	136	*	
Skull, max. width of braincase (approx.)	49		
Skull width of postorb. constr.	35		
Skull, width over orbits	76		
Skull, width of muzzle over canine alv.	51		

Horizon: Duchesne River, Randlett substage.
Locality: 1 mile S. of Baser Bend of Green River, Utah.
* Because of overlapping, the length of premolar and molar series is less than the sum of the measurements of individual teeth.

Family **MERYCOIDODONTIDAE** Thorpe

Oreodontidae Leidy, *Jour. Acad. Nat. Sci. Phila.* Ser. 2, **7**: 71, 1869.

In no respect is the contrast between the Uinta and Duchesne River faunas more striking than in the representation of this family. In the Uinta these fossils, especially the genus *Protoreodon*, are the commonest of mammals, while in the Duchesne River they are excessively rare. With a doubtful exception in the Upper Washakie, the family appears for the first time in the lower Uinta, or Wagonhound substage and must have been immigrants from some region, not as yet identified. In the upper Uinta (Horizon C, or Myton substage) there is a great increase of genera and species and, especially, of individuals. In the Duchesne River merycoidodonts are exceedingly rare and, indeed, it is not certain that they have been found in that formation at all. Peterson lists only one specimen, which he refers to ?*Ticholeptus* and says of it: "A fragment of a lower jaw with P^4 and M^1 . . . was perhaps not found in the Uinta Basin at all." [35] A fairly good skull, without mandible, collected by a Carnegie Museum party (C.M. No. 12,049) at the Beaver Divide, is referable to a very distinct species of *Protoreodon*, but, as previously pointed out, the stratigraphic position of the beds immediately below the lowest White River is not clearly established. In my opinion, these beds are, very probably, referable to the uppermost Duchesne River and I have, therefore, included in that fauna the fossils collected there. So very scanty are the fossils of the Duchesne River, both in the Uinta Basin and at the Beaver Divide, that statistical data are of very limited significance. It is not to be believed that the family died out, only to reappear in the lower White River, in which they continue to be rare, but in the succeeding Brulé substage they had a second culmination and became so abundant and characteristic that Wortman named the lower Brulé the "Oreodon Beds." The supposed absence of merycoidodonts from the Duchesne River of the Uinta Basin is assuredly merely an accident of collecting and has no particular significance.

In the same formation at the Beaver Divide are found representatives of both oreodont families, *Protoreodon* and *Mesagriochoerus*, and, as pointed out before, the latter genus, which is characteristic of the Duchesne River, is intermediate between the White River *Agriochoerus* and the Uinta *Protagriochoerus* in the pattern of the upper molars and especially in the reduction of the protoconule, which is small on m^1 and m^2, vestigial or absent on m^3. The same is true of the species of *Protoreodon* from the Beaver Divide, which is here ascribed to the Duchesne River, though the genus has not yet been found in the Uinta Basin above the level of the Myton substage of the Uinta. In both families, therefore, there appears to be a complete transition between the Upper Eocene species, which have well-developed and conspicuous protoconules and the White River species, in which they have disappeared altogether.

The late Professor T. B. Loomis and, following him, Dr. Malcolm Thorpe, have maintained that the conules on the upper molars of *Protoreodon*, *Protagriochoerus*, etc., were additions to a primitively quadricrescentic molar, such as appears in the Mongolian *Archaeomeryx*.

Loomis writes:

> In figure 3 I have shown a series of five types of upper molars. . . . I can see no reason for assuming that the selenodont illustrated in *E* [i. e. *Merycoidodon*] is derived from any of the others. It is the simplest of the whole series. . . . I can not but feel that . . . the four cusped molar [goes] back to an early Eocene stock as yet unknown. The earliest form which shows the characters of the modern artiodactyls is *Archaeomeryx* from Mongolia and gives no suggestion of there ever having been more than four cusps.[36]

Thorpe accepts this view and says:

> Loomis called attention to the fact that *Archaeomeryx* of the later Eocene of Mongolia is the earliest form which shows in its molar pattern the characters of the modern artiodactyls, and it affords no hint that the molars ever had more than four cusps. The lower first premolar is caniniform, and the true canine is incisiform, as they are in all of the merycoidodonts. *Archaeomeryx* is not ancestral to the family under consideration, but in my opinion it indicates that the true ancestors did not have the fifth lobe, or protoconule, and that *Protoreodon*, possessing the protoconule, is not in the direct line of ancestry. In other words, the true stem stock of the Merycoidodontidae has not yet been discovered.[37]

In his phylogenetic diagram [38] Thorpe shows *Protoreodon* as a side branch, but distantly related to the main stem of family descent.

[35] Peterson, O. A., *op. cit.* **23**: 374, 1934.

[36] Loomis, F. B., *Bull. Geol. Soc. Amer.* **36**: 589, 1925.
[37] Thorpe, M. R., *Mem. Peabody Mus. Nat. Hist.* **3** (4): 24, 1937.
[38] *Ibid.*: 25, fig. 2.

In my judgment this view held by Loomis and Thorpe is quite untenable. Simplicity of molar pattern among mammals is rarely, if ever, a primitive character; but has resulted from a reduction in the number of cusps. Both Loomis and Thorpe emphasize the fact that the molars of *Archaeomeryx* show no sign of ever having had a fifth cusp, but why should such sign be expected to occur, in case the conule had been present in the ancestral form and subsequently lost? One can rarely be positively assured that any two genera of fossil mammals stand to each other in the relation of ancestor and descendant, but, subject to the necessary reservations implied in all phylogenetic discussions, we have in the Bothriodontinae, a subfamily of the anthracotheres, two extremely probable instances of the loss of the protoconule, leaving no sign of its former presence. All of the Oligocene bothriodonts, of which four genera have been described, have very conspicuous protoconules, but in the Miocene *Arretotherium*, which there is every reason to regard as a descendant of *Bothriodon*, there are only four cusps and no trace of the fifth. The same modification took place in India, where the genus *Merycopotamus*, with four cusps in the upper molars, appears to be descended from some bothriodont with five.

There is more direct and positive evidence, which was not known to either Loomis or Thorpe, that the White River *Merycoidodon* was, in literal fact, descended from the Uinta *Protoreodon*. The several species of the latter which occur in the Uinta all have the protoconule conspicuously developed, while in *P. tardus* sp. nov. (described in the following pages) from the Beaver Divide, the conules are much diminished in size and that of m^3 is no more than a vestige.

The same is true of the *Agriochoeridae;* in the Uinta genus, *Protagriochoerus*, the protoconules of the upper molars are as prominent and conspicuous as in *Protoreodon*, while in the succeeding *Mesagriochoerus*, the conules are greatly reduced, almost at the vanishing point. Incidentally, it is of interest to observe that the complete loss of the conules has taken place independently in these three families and probably also in many others, for there is very strong evidence that in nearly all artiodactyls and perissodactyls the molar pattern has passed through the "quadritubercular" stage, in which there are four principal cusps symmetrically arranged in pairs and two much smaller cuspules, or conules, placed between the transverse pairs of principal cusps and, therefore, frequently called "the intermediates." The most ancient of known American artiodactyls, *Diacodexis*, seems to show that there was an antecedent tritubercular stage, but that need not be considered here. The point is, that there is every reason to believe that the absence of the conules, or intermediates, in the upper molars of any artiodactyl is not a primitive character, but has resulted from a process of reduction.

PROTOREODON Scott and Osborn

Protoreodon Scott and Osborn, *Proc. Amer. Philos. Soc.* **24**: 257, 1887.

?*Eomeryx* Marsh, *Amer. Jour. Sci.* Ser. 3, **14**: 364, 1877 (*nomen nudum*).

In the Carnegie and Princeton Museums are contained large numbers of specimens referable to several species of this genus, most of which are from the Myton substage of the Uinta. The material includes several skeletons in various degrees of completeness, so that the osteology is very fully known and will be described in Part II of this monograph, which is to deal with the Uinta mammals. Individually, *Protoreodon* includes the most abundant of Uinta fossils, but in the Duchesne River fauna there is a great change and the genus apparently disappears, so that Peterson did not include it in his list,[39] but where fossils are so exceedingly rare, that seeming absence has no great significance. At the Beaver Divide, in beds which are usually referred to the Chadron substage, was found a skull which I have referred to *Protoreodon tardus* sp. nov. and which is described formally below. I do not feel altogether confident, however, that it would not be better to erect a new genus for it. Under whatever name it be studied, it is most obviously intermediate between the Uinta species of *Protoreodon* and the White River *Oreonetes* and *Merycoidodon*. Perhaps, too, the fossil should be included in the Chadron, rather than in the Duchesne River fauna, but, if truly referable to the former, it must belong in the lowest and oldest portion of it.

For the present, it will suffice to say that all known species of this genus are small animals with unreduced dentition, in which, as in the Oreodontoidea generally, the lower canine appears to be one of the incisors and the first lower premolar is a caniniform tusk. The upper molars have an anterior intermediate conule and moderately concave external crescents, mesostyle not invaded by the transverse valley. The lower molars are much more primitive than those of the White River and succeeding genera of the family; the crescentic cusps are thicker and less complete than in the latter and plainly indicate their derivation from conical cusps.

The manus has vestigial, but complete pollex, ungual phalanges hoof-like.

Protoreodon tardus sp. nov.

(Pl. II, figs. 1, 1*a*)

The principal character which distinguishes this species from those of the Uinta stage is the reduced size of the intermediate conules of the upper molars, especially on m^3 when it is hardly more than vestigial; evidently, these intermediates were on the point of disappearance. If this line persisted into the middle and upper Chadron, it must have passed into *Oreonetes* and

[39] Peterson, O. A., *Ann. Carnegie Mus.* **23**: 374, 1934.

thence into *Merycoidodon* or, perhaps, *Eporeodon*, without a break. The summit of the protocone, or antero-internal cusp is bifid on all three molars, though this fact has no obvious morphological significance; on m^1 and m^2 the antero-internal crescent is incomplete, lacking the posterior horn; the ribs on the buccal faces of the outer crescents are less developed than in the Utah species of the genus, but the styles are more prominent, especially the parastyle of m^3, which is relatively very large. M^3 has an imperfect postero-internal crescent, without posterior horn, and has a sharp-pointed hypocone.

The animal was not quite mature; p^2 was in process of eruption, but p^3–m^3 were all in place and functional. The crown of p^1 has been broken away and lost and of p^2 only the sharp point of the protocone's apex is visible; p^3 was probably the largest of the premolars in antero-posterior diameter; it has a trenchant compressed-conical shape, with sharp edges and acute point; the deuterocone is larger than in the Uinta species of *Protoreodon*, but not so large as in *Protagriochoerus;* it is somewhat asymmetrical in position, placed behind the median transverse line of the crown and is part of the prominent cingulum. The cingulum is high behind and encloses a valley, but becomes very faint anteriorly. P^4 is a little shorter antero-posteriorly and wider transversely than p^3 and has the usual selenodont pattern of two crescents, placed transversely; the cingulum is prominent on the hinder face, but not on the other sides.

The only *milk-tooth* preserved is an upper canine, which resembles its permanent successor, except in being somewhat smaller and more slender.

It is particularly unfortunate that the *skull* was not found until it was so much damaged by the weather, for it is exceptionally little crushed or distorted. On the right side, the face is intact, except for the loss of the zygomatic arch, and most of the brain-case is preserved, but the left side and base of the cranium were destroyed. The short and complete postorbital process of the frontal shows that the orbit was incompletely closed behind, as is also the case in all the known Uinta species of the superfamily and is relatively longer than in the agriochoerids. In front of the orbit, the *maxillary* is conspicuously swollen, as though by an enlarged antrum; the infraorbital foramen is small, low in position and very far forward, opening above p^3. The maxillary is very broad dorso-ventrally in the preorbital area, but has only a minute contact with the frontal, the lachrymal and nasal separating these bones except at one point.

The *premaxillary* is relatively very small; the horizontal ramus has a rather stout alveolar portion and the ascending ramus is extremely narrow, but forms the entire border of the anterior nares, rising to a contact with the nasal. The incisive foramina are very small and the premaxillary spines are long and narrow and are received into a deep, V-shaped notch of the palatine processes of the maxillaries; the notch extends back almost to the line of p^2.

The *nasals* are relatively large and are curved transversely and, more strongly, antero-posteriorly, especially in the anterior third of their length, which has a decided downward curvature. The nasals invade the frontals deeply and end behind in points; from these pointed posterior ends, they broaden gradually forward to their maximum width at the lachrymal suture. From that point, they narrow again for a short distance and, then, are of uniform width for the remainder of their course and have entire, bluntly rounded, decurved ends, which project freely for a quarter of an inch in front of the premaxillaries.

The *frontals* form a nearly plane forehead, with only a slight, transverse convexity; there is a deep, median notch between the frontals, into which the hinder ends of the nasals project and, on each side of this notch, the frontals send out long nasal processes; the anterior border of the frontal is made up almost entirely of the nasal and lachrymal sutures. The postorbital process of the frontal is much shorter than in *P. parvus* and the smooth forehead shows hardly a trace of the temporal ridges; this lack, however, may be due to the immaturity of the animal. The same explanation may account for the low sagittal crest, which does not reach any considerable height until it approaches the occiput.

The *lachrymal* is relatively large and conspicuous in the young animal and forms the antero-superior boundary of the orbit; it is of triangular shape, narrowing forward to a point; the base of the triangle is the orbital boundary, which is notched near the ventral angle and the longest side is the frontal suture. In *Merycoidodon*, of the White River, the lachrymal has a more quadrate shape and the antorbital fossa (or so-called "lachrymal pit") which covers nearly the whole lachrymal bone, is deep and conspicuous, but varies somewhat, apparently according to sex. As with so many other characters, the lachrymal of *Protoreodon tardus* is intermediate between that of the Uinta species of the genus and that of the White River *Merycoidodon;* the antorbital fossa is lacking in the former, large and deep in the latter, while in *P. tardus* it is present, though very shallow and hardly more than incipient.

MEASUREMENTS

	C.M. No. 12,049
Upper dentition length i^1–m^3 incl.	74 mm.
Upper canine, antero-posterior diameter	6
Upper canine, transverse diameter	4.5
Upper milk canine, antero-posterior diameter	5
Upper milk canine, transverse diameter	5
Upper cheek-tooth series, length	57
Upper premolar series, length	26
Upper molar series, length	31
P^3, antero-posterior diameter	8
P^3, transverse diameter	7

P^4, antero-posterior diameter	7 mm.
P^4, transverse diameter	9
M^1, antero-posterior diameter	10
M^1, transverse diameter	12
M^2, antero-posterior diameter	10
M^2, transverse diameter	12.5
M^3, antero-posterior diameter	11
M^3, transverse diameter	14

Horizon: ?Uppermost Duchesne River, or lowest Chadron.
Locality: Beaver Divide, Wyoming.

Order **PERISSODACTYLA** Owen

In the Lower and Middle Eocene of North America, perissodactyls were the dominant ungulates, indeed, the dominant mammals, while artiodactyls were very rare. Presumably through immigration, artiodactyls increased immensely in the Uinta, especially in the Myton substage, but the perissodactyls showed no definite indication of decline other than the loss of relative importance, in spite of the arrival of several new artiodactyl families from the Old World. So far as one can judge from the very brief faunal list, the proportional numbers of the two orders persisted with no particular change through the Duchesne River, in which representatives of the following perissodactyl families have been found: (1) Equidae, (2) Brontotheriidae, (3) Helaletidae, (4) ?Tapiridae, (5) Amynodontidae, (6) Hyracodontidae, (7) Chalicotheriidae. The Rhinocerotidae were probably also present, but have not yet been certainly identified.

Family **EQUIDAE** Gray

For some unexplained reason, remains of horses are very rare in the Uinta, as compared with the White River; in the Duchesne River, they are as yet represented only by a couple of incomplete mandibles, which Peterson believed would prove to be different from the Uinta genus, *Epihippus*, when better material should have been obtained and, for that contingency, he suggested the term *Duchesnehippus*.

EPIHIPPUS Marsh

Epihippus Marsh, *Proc. Amer. Assoc. Adv. Sci.*, 26th Meeting, 236, footnote, 1877.

Intermediate, in regard to the molarization of the premolars, between *Mesohippus*, of the White River, and *Orohippus*, of the Bridger. Granger's account of the Uinta genus is as follows:

> The characters pointed out by Marsh do not serve to distinguish the Uinta from the Bridger forms. The distinctions are rather in the highly developed mesostyle, in the advanced condition of the second upper and lower premolars, in the crescentic external cusps of the upper molars and in the more perfect development of the cross-crests.[40]

Peterson named another species from the Duchesne River, referring it provisionally to the Uinta genus.

[40] Granger, W., *Bull. Amer. Mus. Nat. Hist.* **14**: 232, 1908.

Epihippus intermedius Peterson

Epihippus intermedius Peterson, *Ann. Carnegie Mus.* **21**: 66, 1931.

Peterson described this Duchesne River species as follows:

> *Specific characters;* Antero-internal cusp on P_3 single; antero-internal cusp on P_4, on tooth not worn, very faintly twinned; on very slight wear twinning disappears. On M_1 and M_2 twinning of antero-internal tubercle practically the same as on P_4; P_1 single-rooted. No diastema between P_1 and P_2. Animal slightly larger than *Epihippus gracilis*.
>
> In comparing P_2 of the present specimen with fig. 5*b* on Pl. XVIII in Granger's paper on the "Revision of American Eocene Horses" it appears that the paraconid of *Epihippus gracilis* (= *uintensis*) is less developed and does not turn inward as in *E. intermedius*. Furthermore, when the lower premolars of the type of the new species are compared with those in a specimen, C.M., No. 3,397, referred to *Epihippus parvus*, it becomes quite apparent that the anterior cross-crests in the latter species are higher than the posterior cross-crests, while in *E. intermedius* the anterior cross-crests are no higher than the posterior, exactly the condition found in *Mesohippus bairdii*. P_2 in the latter species differs from that in *Epihippus intermedius*. These differences together with relatively smaller incisors, a larger canine, a longer diastema between P_1 and the canine in *E. intermedius* appear to be the chief differences between *Epihippus intermedius* and *Mesohippus bairdii*.
>
> When the upper dentition of *E. intermedius* is found in the Duchesne Oligocene, it is quite safe to predict that the antero-internal tubercle on P^2 will be much further advanced in its development of molariform structure than it is in *Epihippus parvus*, and that the fifth digit of the manus in *E. intermedius* will be found to be considerably more reduced than it is in the species from the lower levels in the Uinta Basin. That *Epihippus intermedius* may represent a distinct genus is entirely probable. When more satisfactorily determined this new genus may be called *Duchesnehippus*.

An interesting item in the differences between the Duchesne River and the White River horses is in the comparative size of the lower canine, which is distinctly larger in the more ancient genus, although it seems to belong to the incisor-series and follows i_3 without diastema. In a recent publication,[41] I have discussed the problem of the development of the canines in the horse-phylum and have shown that in the White River genera, *Mesohippus*, *Miohippus*, *Pediohippus*, the canines, upper and lower, are much reduced, as compared with those of the Eocene genera and the lower one is nearly incisiform. In the John Day, there began a re-enlargement of the canines, leading eventually to the Recent condition. The fossils, thus, seem to record a fluctuation in the phylogenetic development of the canines, which apparently contravenes Dollo's principle of the "irreversibility of evolution," which is so generally accepted and, yet, if such a degree of fluctuation in development be not admitted, it will be necessary to remove almost every one of the American Oligocene horses from the direct line of equine descent. Had Dollo's attention ever been

[41] Scott W. B., G. L. Jepsen, and H. E. Wood, *Trans. Amer. Philos. Soc.* **28**: 912, 1941.

directed to this instance, he might have thought that such a fluctuation was too trivial a matter to constitute a real exception to his "law," according to the legal maxim: "*de minimis non curat lex.*"

Exactly the same situation is revealed in the developmental history of the true camels, in which all the anterior teeth, canines and incisors alike, are first much reduced in the Upper Eocene genera and then gradually re-enlarged in the Oligocene and Miocene forms.[42]

In the table of measurements which follows, Peterson's figures have been repeated and verified; in case of differences, his dimensions are given in parentheses.

MEASUREMENTS

	C.M. No. 11,845
Length of jaw-fragment, incl. incisors	86 (84) mm.
Length of diastema between canine and p_1	18 (13)
Cheek-teeth, length p_1–m_2	50 (49)
P_2, antero-posterior diameter	9
P_2, transverse diameter, posterior part of crown	5 (4.5)
P_3, antero-posterior diameter	8.5
P_3, transverse diameter	6
P_4, antero-posterior diameter	9
P_4, transverse diameter	7 (6)
M_1, antero-posterior diameter	9
M_1, transverse diameter	7 (6)
M_2, antero-posterior diameter	9
M_2, transverse diameter	6.5 (6)
Mandible, depth at p_2	15.5
Mandible, depth at m_2	19

Horizon: Duchesne River, Halfway stage.
Locality: Halfway Hollow, Uinta Co., Utah.

FAMILY **BRONTOTHERIIDAE** MARSH

The Bridger, Washakie, and Uinta stages of the Eocene are characterized by great numbers of brontotheres, which, in the first two stages named, are almost all of moderate or medium size, about equalling the American Tapir in stature. So marked is this resemblance, that the genera were long called by the noncommittal name of "tapiroid." In the Uinta, most of the medium-sized species seem to have died out and to have been replaced by animals that may fairly be called large, though far smaller than the huge creatures which were so abundant in the Chadron stage of the White River. Two genera of the comparatively large-sized brontotheres, of the Uinta have been named, *Diplacodon* and *Protitanotherium*. In the Duchesne River, only a single genus, the White River *Teleodus*, has so far been discovered, but there can be little doubt that this great reduction was more apparent than real and due rather to the rarity of fossilization than to such wholesale disappearance of the mammalian fauna. It is to be expected that the larger brontotheres of the Uinta *Protitanotherium* and *Diplacodon*, or their little modified descendants, will eventually be found in the Duchesne River beds.

[42] *Ibid.*

In Bridger and Washakie times the brontotheres were nearly all hornless and such of the skulls as show signs of having had dermal, rhinoceros-like horns, had them in incipient, hardly recognizable form, but in the upper Uinta (Myton stage) conspicuous, bony knobs made their appearance, becoming, in the White River, immense and grotesque outgrowths of the skull. It is customary to call these protuberances "horns" and, very probably, such they were in function; evidences of fighting occur in the skeletons. In their earliest form, as in *Manteoceras* of the Washakie, the only evidence of horns is the paired roughening of the nasal bones, to which small dermal horns must have been attached. This may also have been true of the genera with small bony knobs, such as *Diplacodon*, of the Uinta and *Teleodus*, of the Duchesne River, but the monstrous "horns" of most White River genera must have been pedicles, greatly enlarged and with no indication of their having supported dermal horns. Their shape precludes the suggestion that they might have been cores with horny sheaths. The medium-sized, hornless animals, so characteristic of the Bridger and Washakie, have become few and rare in the Uinta and lacking, apparently at least, in the Duchesne River. The change from the Uinta to the last named formation may be largely deceptive because of the scantiness of the fossils, but it is probable that the comparatively small, hornless brontotheres had given way entirely to the larger, horned genera. Only two genera, *Teleodus* and ?*Protilanotherium*, have been obtained, as yet, and in surprisingly large numbers, but all the specimens have been obtained from a single "quarry," none whatever from any other locality. Under such circumstances, statistics are without significance, but the discovery of a White River genus in the Duchesne River beds is of great stratigraphic interest and importance.

TELEODUS MARSH

Teleodus Marsh, *Amer. Jour. Sci.*, ser. 3, **39**: 524, 1890.

Peterson's description of the Duchesne River species may be reproduced here with advantage.[43]

Generic Characters. $I\frac{2}{3}$, $C\frac{1}{1}$, $P\frac{4}{4}$–$?\frac{3}{3}$, $M\frac{3}{3}$.
Canines with short crowns, especially in the females. Skull brachycephalic. Bases of horns elongate oval in transverse section.

Teleodus avus Marsh (No. 10,321, Yale Museum) is based upon the greater part of the lower jaws and was found near the base of the Oligocene of Dakota. This specimen, the type of the genus, clearly pertains to a later form, the chief features of which are: (*a*) the crowded condition of the lower incisors, I_3 with an extremely short root and almost crowded out of its original position in the alveolar border; (*b*) the alveolar border of the incisors occupies a straight transverse line between the lower canines and does not extend in front of the canine teeth; (*c*) the cheek-teeth are relatively more developed than in other species, being broader, with more inwardly slanting external faces, especially in the case of the molars.

[43] Marsh, *loc. cit.*

Teleodus primitivus (Lambe) from the Cypress Hills of Canada is an earlier or more retardant [*sic*] species. In this species the alveolar border of the incisors extends well in front of the canines with a more liberal space for the incisors. Whether or not the presence of P_1 in *T. primitivus* is due to the young, though adolescent, stage of the type specimen it is hard to determine; but the relatively long, narrow cheek-teeth, with vertical external faces, especially in the case of the molars, are characters of strong specific value. The longer diastema between the canines and P_1 and the relatively long and narrow mandible are additional distinctive features of *T. primitivus*. The delicately constructed canines in the type-specimen may well be due to sex.

Teleodus uintensis Peterson

Teleodus uintensis Peterson, *Ann. Carnegie Mus.* **20**: 308, 1931.

Type: Lower jaws, practically complete, but crushed in the symphysial region, No. 11,809, female, Carnegie Museum.

Paratypes: Skull complete, slightly depressed by crushing, No. 11,759, female, Carnegie Museum; lower jaws complete but crushed in the region of the angle, No. 11,761, Carnegie Museum. In addition there are over twenty individuals from the same quarry typical of the species, which will be consulted in connection with publications of the Carnegie Museum in the near future.

Specific Characters: Smallest known titanothere of the Oligocene. In anatomical structure the species is intermediate between *Teleodus avus* and *Teleodus primitivus*. Incisors as in *T. avus*, but less crowded and alveolar border slightly further advanced in front of the canines. P_1 present or absent. Diastema between canine and cheek-teeth present or absent. Molar-premolar dentition relatively broad and external faces of molars less vertical than in *T. primitivus* of the Canadian Oligocene.

The female skull, C.M. No. 11,759, one of the paratypes, is the most perfect specimen of the series.

Its contour is less brachycephalic than those of the males. The small, round-topped, button-like crowns of the two upper incisors of the left side are of nearly subequal size, separated from those on the right by a deep median invagination of the alveolar border. Incisor three is crowded close to the inner side of the canine. The latter is of small size (clearly a sexual character) with short and blunt crown and a prominent posterior cingulum. Following the canine, without diastema, P^1 appears nearly as broad as long and well worn, so that its detailed structure is practically obliterated. Other individuals show the structure of P^1 perfectly. P^2 has the tetartocone indistinctly separated from the deuterocone. P^3, in one or two cases, is seen to have the tetartocone poorly indicated, but in the great majority of the skulls and upper dentitions under study the deutero- and tetartocones are distinctly marked. The tetartocone on P^4 is small, though distinctly separated from the deuterocone by a well-marked constriction of the inner lobe. The inner cingula of the premolars are usually well indicated, while externally they vary in different individuals. In the paratype, No. 11,759, the hypocone of M^3 is distinct and of large size, but in most cases this element is small and has no diagnostic value, due to variation in the different specimens. The parietals, in all the skulls from the new quarry in the Upper Uinta, present a prominent convexity, which is especially well developed on male skulls. This convexity is observed in the crania of other Oligocene titanothere, *e. g. Brontops*, *Megacerops*, *Brontotherium*, but not so general or proportionately as large as in the species from the Upper Uinta.

In the type, No. 11,809, the mental foramen is located below P_4, while in the paratype No. 11,761, this foramen is below P_3. This discrepancy is, in part, due to crushing of both specimens. The anterior part of the symphysis in the paratype is much depressed by crushing. The incisor alveolar border of the type is imperfect, while in the paratype it is complete, and there is a space between the median incisors of about five millimeters. I_1 and I_3 are subequal in size. The canine is small, with a postero-internal basal cingulum projecting at the base of the crown. In the type the diastema between the canine and premolars is much shortened by crushing, while in the paratype it is equally clear that the diastema is lengthened and the symphysis in general has a procumbent and unnatural appearance due to crushing from above downward. This crushing is also observed in the region of the condyle and the coronoid process, *see* pl. XV. In the type P_1 is absent in both jaws, while in the paratype this tooth is represented by the root on the left and by an alveole on the right side. The rest of the cheek-teeth are much worn in both specimens. The cingula are rather weak, while the teeth are relatively broad, when compared with *T. primitivus* of Canada and relatively less broad than in *T. avus*.

Mr. Peterson's description of *Teleodus* was preliminary and he hoped to follow it with a more detailed account in the publications of the Carnegie Museum, but, unfortunately, his lamented death in November 1933 prevented the accomplishment of this intention. The kindness of Director Avinoff and Messrs. J. Leroy Kay and John Clark has given me the opportunity to carry out Mr. Peterson's plan and the following description was prepared during my visit to Pittsburgh in October and November 1941.

DENTITION

None of the twenty or more skulls found in this wonderful "quarry" in the Duchesne River beds, eleven miles west of Vernal, Utah, has its lower jaw attached to it, or even distinctly associated with it and the number of separate mandibles is surprisingly small, much less than that of the skulls; there are only three mandibles for twenty-three skulls and it is difficult to imagine how all of the lower jaws became detached. All three of the mandibles pertained to old animals with much worn teeth, while the skulls are of all ages except the juvenile.

The dental formula is $i\frac{2}{3}$, $c\frac{1}{1}$, $p\frac{4}{4}-\frac{3}{3}$, $m\frac{3}{3}$; the number of upper premolars is variable.

Upper Teeth.—The *incisors* are very small and, like those of the White River genera, have shoe-button-like spheroidal crowns, which can have been of little or no use to their possessors, for, even in old animals with much worn molars, they show no sign of abrasion.

The *canines* are relatively small, but were still functional tusks, projecting well below the level of the masticating surface of the grinding teeth; the anterior side of the crown is convex and the posterior concave, giving the tooth a recurved shape; at the base is a posterior cingulum, almost a heel. One of the most striking contrasts between the brontotheres of the

Bridger and those of the White River is in the relative size of the canines. In the Middle Eocene genera, such as *Palaeosyops* and *Telmatherium*, the canines are formidable tusks, proportionately as large as in the Grizzly Bear, while, in the White River, there is much variation in the size of these teeth, but in none of the genera are the tusks comparable to those of the Bridger forms and, in most White River species, the canines must have been useless as weapons, for their points do not project below, or above, the grinding surfaces of the premolars.

The *premolars* are very small in comparison with the molars and, except p^1, are what is usually called "molariform," but, in both the rhinoceroses and the brontotheres, the term is inexact, for, in both of these families, the external wall of the crown remains constantly different in molars and premolars; in the molars the two external lobes are deeply concave on the buccal side, while in the premolars, the outer lobes have convex and ribbed buccal sides. In the other perissodactyl families, horses, tapirs and palaeotheres, there is no such constant difference between molars and premolars; in the early Eocene and, in many instances, in the middle Eocene, none of the premolars has assumed the molar pattern, but, from the Bridger upward, the premolars, one by one, become molariform, until all of them, except the first, resemble the molars, except for the differences as noted above.

P^1 is much the smallest of the series in *Teleodus*, though it is carried on two roots, and its cuspidation is difficult to make out, for it is worn, even in those skulls in which the other teeth show little sign of abrasion. Very probably, this tooth was not changed. There appear to be four cusps, anterior and posterior, internal and external, with a small postero-internal valley, or pocket. The six following teeth increase in size posteriorly from p^2 to m^3, with sudden increment at m^1; each tooth is larger than the one in front of it and smaller than the one behind it. The premolars, p^2 to p^4, have all the elements of the molar crown, but in different degrees of approximation and, as above noted, in each of them the external wall is unlike that of the molars. In the latter the two external cusps are deeply and conspicuously concave, with very prominent mesostyle, while in the premolars these cusps are convex, or flat. The external cusps are ribbed, the anterior ones particularly so. Seen from the buccal side, the two categories of teeth are strikingly different, though their grinding surfaces are much alike.

P^2 has two external cusps, of which the posterior one (tritocone) is the larger; very short cross-crests are on the inner, or lingual, face of these cusps and an enamel pocket is enclosed by these crests; there are two internal cusps, not very distinctly separated, the deutero- and tetartocone, of which the former is much the larger; the abortive cross-crests do not reach these inner elements. The prominent cingulum passes around three sides of the crown and is especially heavy on the anterior and posterior faces.

P^3 is like p^2, but is larger and its cusps are more distinctly demarcated; the cross-crests, however, are even smaller and the larger cusps are the postero-external and the antero-internal and the enamel pocket has a more symmetrical position, near the middle of the fore-and-aft diameter of the tooth. The cingulum is complete, except externally and turns upward on the inner face of the deuterocone.

P^4 is the most molar-like of the series; the two external cusps are of nearly equal size and the anterior one has a median rib, while the posterior one is slightly concave and the three external styles are present in an incipient stage; the cingulum is as complete as on the other premolars. In one respect, however, p^4 is less completely molariform than p^3, namely the relatively smaller size of the postero-internal cusp, or tetartocone.

The *molars* are essentially of the same pattern as in the Lower Eocene *Lambdotherium* and in all other known members of the Brontheriidae; the two external cusps, para- and metacones of Osborn's nomenclature, have deeply concave buccal faces, without ribs, and very prominent mesostyles, formed by the junction of the adjacent horns of the outer crescents; para- and metastyles can hardly be said to exist, though the effect of styles is produced by the outward curvature of the crescent borders. The free, ventral margins of the crescents are produced downward into points and this gives a characteristic **W**-like cutting edge to these teeth, which shears down outside of the lower molars. The cross-crests, which characterize the upper molars of all other perissodactyl families, are lacking in all known brontotheres, even in the earliest, *Lambdotherium*, and the intermediate conules are reduced to vestiges, or are altogether wanting. In the later chalicotheres the transverse crests are much reduced and the brontothere condition is approximated, but, unless the supposed Uinta and Bridger Ancylopoda are mistakenly referred (e. g. *Eomoropus*) the reduced cross-crests are secondary, not primitive. In addition to the median enamel pocket, which the premolars possess, there is a posterior one, which is inside of the hinder external crescent and is smallest on m^3. Internally, there are two conical cusps, the proto- and hypocones, which have no connection with the outer wall and are entirely isolated. The upper molars of the Brontotheriidae are thus highly characteristic and almost unique among perissodactyls. In *Teleodus*, the two internal, conical cusps are of almost the same size in m^1 and m^2, but in m^3 the hypocone is very much reduced, hardly more than a remnant. The cingulum does not embrace three sides of the crown so distinctly as it does in the premolars and differs in prominence on the different sides and also according to the position of the tooth in the molar series; in m^1 the cingulum is prominent on the front and rear faces of the crown,

very weak on the lingual side, though crossing the inner valleys and descending on the internal face of the antero-internal cone, somewhat as in p^2. In m^2 the outer part of the anterior cingulum is concealed by the close juxtaposition of m^1, but the inner half is high and, on the internal and posterior faces of the tooth, it is very much as in m^1. On the anterior face of m^3 the cingulum is low, but very distinct on the side of the antero-external crescent, while its inner half is relatively high, much higher than on any other tooth; internally also the cingulum is much more prominent, but is interrupted on the face of the protocone, or antero-internal cusp; otherwise, it is continuous around three sides of the crown.

The upper molars differ not only in size, but also in shape; in the outline of the crown, m^1 is symmetrical, rectangular and nearly square, with anterior and posterior transverse widths almost equal; m^2 is less symmetrical, owing to the outward projection of the anterior horn of the antero-external crescent, but the width is nearly the same before and behind. M^3 is decidedly asymmetrical, the anterior breadth exceeding the posterior, in the ratio of 69 to 56, because of which the buccal face seems to slope inward and backward and each crescent is inclined in similar fashion; the anterior crescent is rendered more deeply concave than in any of the other molars by the great prominence of the anterior horn.

There is every reason to suppose that all of the individuals found in the Quarry belong to the same species and yet, if so, surprising differences are found in the upper molar teeth. In No. 11,754, for instance, a young adult, in which m^3 was not completely erupted, the ribs on the buccal faces of the outer crescents are faintly marked, or entirely absent, whereas, in No. 11,866, these ribs are conspicuous.

Lower Teeth.—Peterson's account of the lower *incisors*, as already quoted, needs no addition. As he pointed out, there are three incisors in each ramus, the only known Oligocene genus of brontotheres of which that is true. The upper incisors, as before noted, are reduced to two and, in the White River, the number fluctuated in different individuals, or, perhaps species, from three to none. In *Teleodus*, the incisors are definitively of the useless, vestigial, Oligocene type as compared with the large, pointed, functional form, which is characteristic of the Eocene genera. All three of the mandibles, which the Duchesne River collection contains, are of old individuals, with much worn cheek teeth, but the incisors show no sign of abrasion.

The *canine* is small and inclined forward, much worn on the apex and posterior face, evidently by the abrasion of the upper canine, for the lower tusks project above the level of the grinding teeth.

The *premolars* number three in one of the mandibles; in one (C.M. No. 11,809) p_2 follows the canine without diastema and with only space sufficient for the occlusion of the upper tusk; there cannot have been a first premolar in this jaw. In a second specimen (C.M. No. 11,761) the number of premolars is four, and there is a considerable gap between the canine and p_2, in which is a very small remnant of a single-rooted p_1. This is the jaw figured by Peterson and, though decidedly old, with much worn teeth, it is somewhat younger than No. 11,809, which may have had an additional tooth, when young. Like the upper teeth, those of the lower jaw increase in size posteriorly, m_3 being much the largest of the grinding teeth; p_3 and p_4 are molariform, p_2 not quite so, for the anterior crescent is incomplete. All the other grinders are bicrescentic, the two crescents being placed one behind the other, and m_3 is enlarged by the addition of a basin-like heel; remnants of an external cingulum appear on several of the teeth, notably on m_3.

This bicrescentic pattern of the lower molars is very widely distributed among various groups of artiodactyls, perissodactyls, chalicotheres and the South American Litopterna, so that its presence is no proof of relationship. Originally, Leidy [44] was misled by it into referring the titanotheres (brontotheres) to the artiodactyls, family Anoplotheriidae; it was especially common in the Eocene and early Oligocene and, from the beginning to the end of their recorded history, the brontotheres displayed it. It is interesting to note that no hoofed mammals of Recent times possess it in unmodified form; it persists in the horse family, but is so masked by complications, as hardly to be recognizable.

SKULL

The Duchesne River Quarry, which has yielded so many skulls of *Teleodus*, does not contain a single uncrushed, undistorted specimen and the multitudinous, matrix-filled cracks have so obscured the sutures that but very few of the bones are distinguishable. This is true of even the youngest individuals, in which some of the milk-teeth are retained. Little can be done, therefore, in the way of description, more than to give an account of the various aspects of the skull, side, top, base and rear, but even in these general descriptions, it is often extremely difficult to make proper allowance for the effects of crushing. In most instances, the pressure has been downward and due, no doubt, to the weight of overlying sediments, for the formation has been subjected to very little diastrophic movement. The effect of vertical pressure has usually been to flatten the skull by reducing its dorso-ventral diameter, but there are some cases of telescoping, which has shortened and broadened the skull. Mr. Horsfall's drawings (pl. VII, figs. 1, 1*a*, 1*b*, 2, 2*a*) are, I believe, a very successful solution of the problem of distortion, but they leave much uncertainty concerning the limits of the bones.

Side View.—The skull shown in plate VII is the same individual as that figured by Peterson,[45] but in

[44] Leidy, J., *Jour. Acad. Nat. Sci. Phila.*, Ser. 2, **7**: 206, 1869.
[45] Peterson, O. A., *Ann. Carnegie Mus.* **20**: pl. XII, 1931.

his plates no attempt was made to correct the distortion. A comparison of Peterson's figures with those of plate VII in this paper will show the amount of change deemed necessary for this correction. The first glance suffices to show that this skull is Oligocene in character, in contrast with the Upper Eocene genera, such as *Diplacodon* and *Protitanotherium*. The small horns make it probable that this skull pertained to a female; other skulls, from the same quarry, which are interpreted as males, have larger, more prominent and rugose "horns" and more robust zygomatic arches. In this aspect of the skull, one is immediately struck by the large swelling, or convexity, in the parietal region, which so conspicuously characterizes this animal and is not known to occur in any other genus. I am at a loss to understand Peterson's meaning, when he says: "This convexity is observed in the crania of other Oligocene titanotheres; e. g. *Brontops*, *Megacerops*, *Brontotherium*, but not so general, or proportionately as large as in the species from the Upper Uinta." [46] Certainly, no other known member of this family has anything comparable to this hump. It is quite possible that the posterior part of the brain-case and the occiput are represented as too low in my plate and that they should be drawn more as in *Diplacodon*, though in lesser degree, for, even in the supposed males of *Teleodus*, the horns are much smaller than in the Uinta genus.

The extreme shortening of the face and elongation of the cranial region which characterize all of the White River brontotheres, despite the excessively small brain capacity, are equally marked in *Teleodus;* the anterior rim of the small orbit is above the front edge of m_1 and the postorbital processes of both frontal and jugal are more distinct than in most White River skulls, though there is great variation in regard to this. The orbit appears to have a higher position than in the latter, with narrower space above it, but, how far this is due to down-crushing, it is difficult to say. The infraorbital foramen is large and conspicuously open, placed very far forward, quite near to the hinder border of the narial incision and directly in front of the orbit. In this case, it would be more accurate to call the foramen preorbital rather than infraorbital. The very small premaxillae are concealed, in sideview, by the canine. The freely projecting portion of the nasals is very long and extends somewhat in front of the incisors.

As is usual in this family, the horns are formed chiefly by the nasals, capped by extensions of the frontals. In the White River, there is very great variability in the size and shape of these horn-like, bony outgrowths of the skull, but in all the skulls of *Teleodus uintensis*, the horns are very small, even in those which are believed to be males. This is the more remarkable, because in the Uinta genera, *Diplacodon* and *Protitanotherium*, the horns are much larger than they are in *Teleodus*, although the latter is White River and Duchesne River in date. *Menodus heloceras* (Cope), (to use Osborn's nomenclature) of the White River, has horns almost as small, proportionally, as those of *Teleodus*, far smaller than in other White River genera, in which the grotesque size of the horns is characteristic.

The zygomatic arch is long, laterally compressed, and relatively thin, usually a female characteristic; in one old male the arch is much stouter and the squamosal portion of it is rugose, but there is no approach to such massiveness, or roughness as occurs in many White River skulls, which, there can be little doubt, were derived from old males. This massiveness and rugosity reach a grotesque maximum in the species which Cope named *Symborodon bucco* (*Megacerops bucco* Osborn). The jugal is very long and has a long suture with the zygomatic process of the squamosal, beneath which it extends, but does not reach the glenoid cavity. No sutures are distinguishable in the temporal fossa, which is an elongate concavity with raised borders, made up of the parietal and frontal dorsally, the exoccipital behind and the squamosal below. The postglenoid and posttympanic processes are in sutural contact, converting the auditory meatus into a tube. The ventral part of the exoccipitals, with the condyles, projects very prominently backward, obviously a result of crushing, but, as none of the skulls is undistorted, no attempt has been made to show the normal position of these bones. The paroccipital process is relatively short, not projecting below the level of the postglenoid, from which it is widely separated—perhaps another result of crushing.

Top View.—The outline of the skull from above is wedge-shaped, the base of which is at the widest part of the zygomata, on a line passing just in front of the two glenoid cavities. Thence, the outline narrows forward to the premaxillaries, without interruption and with nearly straight sides. This figure (pl. VII, fig. 1*a*) is strikingly like the corresponding view of the skull of the White River rhinoceros, *Subhyracodon* [47] and differs as conspicuously from the two White River types of brontothere crania; in one of these types the skull widens gradually and regularly forward from the occiput to the base of the horns (*see* Osborn,[48] and in the second type the two sides of the skull are nearly parallel, producing a grotesque effect. The parallel-sided skull is usually associated with extravagantly large, antero-posteriorly compressed horns, making it one of the most bizarre of known mammalian skulls. Whichever of the two types of skull (Osborn, *A* or *B*) be selected for the comparison, the difference between the White River and the Duchesne River types and the

[46] *Ibid.:* 310.

[47] Scott, W. B., *Trans. Amer. Philos. Soc.* **28**, pt. 5: pl. LXXIV, fig. 1*a*, 1941.

[48] Osborn, H. F., The Titanotheres of Ancient Wyoming, etc. *U. S. Geol. Surv. Monograph* **55**: 463, fig. 393 *C* and *D*, 1929.

likeness of the latter to that of early Rhinocerotidae is not without interest.

Returning to a consideration of the top view, we may note that the zygomatic arches are thin transversely, the temporal openings narrow and elongate and that the sagittal crest, which is so conspicuous in the Middle Eocene genera of the family, has entirely disappeared and the cranial roof made flat by the development of sinuses within it, so that, except for the parietal bump, above mentioned, the cranium is flat transversely, concave antero-posteriorly, an obvious resemblance to the skull of the post-White River true rhinoceroses. The brontotheres are not nearly related to the Rhinocerotidae, despite the many remarkable resemblances between the two families, in their later members, and the recorded history of the two groups clearly shows that these resemblances form a remarkable example of convergent development. The likenesses may be traced, step by step, through the Lower, Middle, and Upper Eocene into the Oligocene and are obviously conditioned by steadily increasing bodily size and, more particularly, by constant increase of bulk and massiveness. The rhinoceros-like appearance of the skull is the mechanical response to large nasal weapons and the inverted arch of the skull top is a means of strengthening it against shock. The parietal hump and the naso-frontal horns are not conspicuous.

Base View.—The very small *premaxillae* are emarginated in the medium line between the two middle incisors and the incisive foramina are peculiar in not visibly perforating the premaxillaries, but are concealed by a shelf-like extension of the palatine plates of the maxillaries underneath them, which also hides the premaxillary spines from view. The hard palate is elongate, moderately vaulted transversely and widening posteriorly, as the tooth-rows diverge. The *palatine* bones contribute but a small share to the bony palate, for the posterior nares open far forward, opposite m^3, and the suture is on a line with the front edge of m^2, exposing two large vacuities, one on each side of the vomer. These are similar to, but much smaller than, the openings in *Menodus giganteus* or *Megacerops bucco* (to use Osborn's terms) as shown in that author's great monograph on the titanotheres.[49] The posterior narial canal is long and has rather low walls, which extend almost to the glenoid cavities, the pterygoid border sloping up to those cavities, no sutures between palatines and pterygoids are visible. In all the skulls in which the base has been exposed, the crushing obscures or obliterates the structure. No sign of tympanic bullae is to be seen and even the internal opening of the auditory tube is concealed. The cranial base behind the postglenoid processes is broad and flat, except for a medial keel; the paroccipital processes are widely removed from the postglenoids, to which they bear considerable resemblance in shape. The occipital condyles are broad transversely, but have relatively small dorso-ventral diameter.

Rear View.—The downcrushing, to which all the skulls of the "Titanothere Quarry" have been subjected, has so distorted the occiput, that none of them gives a clear picture. In its crushed condition, the occiput appears to be low and very broad and of rectangular outline, with a deep fossa above the condyles. In its original condition, however, it must have been much higher and narrower and probably shaped much as in the Uinta genus *Diplacodon*.

Mandible.—Attention has already been directed to the strange disproportion in numbers between the skulls and lower jaws occurring together in the "Quarry," 23 to 3, and not one of the skulls has its mandible attached to it. One of the lower jaws (C.M. No. 11,809) shown in plate VII, figure 1, has been much less crushed than the skulls, but has not entirely escaped distortion, for the left ramus has been pushed forward an inch or so beyond the right, but, otherwise, the shape would seem to have been little changed. Except for its small size, this jaw might belong to any one of the so-called species of the White River. The chin rises with a rather steep inclination, but is less abruptly rounded than is usual among the White River forms; there is a single large mental foramen beneath p_4. The horizontal ramus is moderately deep dorso-ventrally and deepens backward very gradually, the ventral border being nearly straight and becoming slightly concave just in advance of the angle. Transversely, the ramus is compressed and has almost flat sides, which is in marked contrast to the jaw-fragment, C.M. No. 11,996, which is so much thicker and dorso-ventrally shallower.

The front of the ascending ramus is so different on the two sides, that compression must have been involved; that on the right side must be the less altered. Behind m_3, the alveolar border becomes narrow and, after an angulation, passes into the inner border of the coronoid. The outer border of that process is continued down to a level below m_3 and bounds a shallow fossa. The ascending ramus of the mandible is broad and high, with the condyle much raised above the level of the teeth; the posterior border is straight and nearly vertical, the angle projecting hardly at all beyond the condyle. The masseteric fossa is shallow and not well defined, the angle rounded and descending somewhat below the ventral border of the horizontal ramus, from which it is separated by a shallow concavity; the angle itself is thickened, but not comparably to the jaw of a modern rhinoceros. The condyle is much extended transversely, projecting both outside and inside of the ramus. The coronoid is weak, but high and recurved and the sigmoid notch is broad and well defined.

Feet.—Associated with the skulls in and near the "Quarry" are several bones of the fore and hind feet, which are striking for their small size. The metacarpals are considerably longer than the metatarsals,

[49] *Ibid.*

but all of the metapodials are damaged. A number of astragali are the only tarsals preserved and these are of interest as being intermediate in form between those of such Eocene genera as *Palaeosyops* and *Telmatherium* and those of the White River type, as exemplified by *Brontops*. In the latter, the bone is conspicuously short proximo-distally and broad transversely; the neck has almost disappeared, the trochlea is much shortened and the cuboid facet is very large, relatively almost as broad as in a modern rhinoceros. In the Eocene *Palaeosyops*, although not believed to be in the direct line of brontotherian descent, is sufficiently near to be a suitable example, the astragalus, both trochlea and neck, is much more elongate proximo-distally and relatively narrow, while the facet for the cuboid is very small. As already noted, the astragalus of *Teleodus* is intermediate between these two extremes. It is shorter, neck and trochlea, than in *Palaeosyops*, longer than in *Brontops* and the cuboid facet is somewhat narrower than in the latter, but much broader than in the former. Altogether, this astragalus is somewhat nearer to the White River than to the Bridger type, as might have been expected, *a priori*.

MEASUREMENTS

	C.M. No. 11,754	*C.M. No. 11,759*
Skull, length occ. cond. to prmx.	523 mm.	508 mm.
Skull, length occ. crest to anterior end of nasals	513	521
Cranium, length occ. crest. to anterior border of orbit	410	368
Skull, width over horns	148	153
Skull, width over zygomatic arches (max.)	354	289
Skull, width of occiput	215	167
Face, length from orbit to tip of nasals	98	180
Nasals, width of free portion	92	91
Upper dentition, length i^2 to m^3 inc.	293	248
Upper incisor series, length	16	
Upper canine, antero-posterior diameter	22	19
Upper cheek-tooth series, length	268	232
Upper premolar series, length	94	95
Upper molar series, length	174	141
P^1, antero-posterior diameter	14	14.5
P^1, transverse diameter	13	14
P^2, antero-posterior diameter	21	20
P^2, transverse diameter	26.5	24
P^3, antero-posterior diameter	26	25
P^3, transverse diameter	32	30
P^4, antero-posterior diameter	35	28
P^4, transverse diameter	39	35
M^1, anterior-posterior diameter	46	34
M^1, transverse diameter	45	38
M^2, antero-posterior diameter	61	50
M^2, transverse diameter	53	52
M^3, antero-posterior diameter	65	56
M^3, transverse diameter ant. half of crown	61	56
M^3, transverse diameter post. half of crown	54	45

	C.M. No. 11,809
Lower dentition, length i_1–m_3	279
Lower cheek-tooth series, length	249
Lower premolar series, length	80
Lower molar series, length	172
P_2, antero-posterior diameter	23 mm.
P_2, transverse diameter	13
P_3, antero-posterior diameter	25
P_3, transverse diameter	19
P_4, antero-posterior diameter	33
P_4, transverse diameter	22
M_1, antero-posterior diameter	42
M_1, transverse anterior	23
M_2, antero-posterior diameter	49
M_2, transverse diameter	28
M_3, antero-posterior diameter	82
M_3, transverse diameter	31

	C.M. No. 11,809
Mandible, max. length from angle, right side	410
Mandible, max. length from angle, left side	390
Mandible, length of symphysis	115
Mandible, depth of ramus below p_4	70
Mandible, depth of ramus below m_3	68
Mandible, thickness of ramus below m_2	27
Mandible, breadth of angle diagonally from m_3	147
Mandible, height of condyle	182
Mandible, height of coronoid	233

	C.M. No. 11,756
Astragalus, prox.-dist. length, fib. side	56
Astragalus, prox.-dist. length, tib. side	54
Astragalus, width of trochlea	53
Astragalus, width of dist. end.	52
Astragalus, width of navic. facet.	33
Astragalus, width of cuboid facet	20
Metacarpal II, length	115
Metacarpal II, prox. width	34
Metacarpal III, length	123
Metacarpal, III prox. width	27
Metacarpal III, dist. width	31
Metatarsal II, length	97
Metatarsal II, prox. width	24
Metatarsal II, dist. width	29

Horizon: Duchesne River, Lapoint substage.
Locality: "Titanothere Quarry, 11 m. W. of Vernal, Utah."

?PROTITANOTHERIUM HATCHER

Protitanotherium Hatcher, *Amer. Naturalist* **29**: 1084, 1895.

In the Carnegie Museum there is a fragment of a lower jaw, containing the three molars (No. 11,996), which is so different from the corresponding part of the *Teleodus uintensis* mandible that it probably pertains to a different genus of the brontotheres. This is all the more likely because the fossil was derived from a lower and older horizon, the Halfway, while all the specimens of *Teleodus uintensis* were obtained in the Lapoint substage, which is at the summit of the Duchesne River formation in the Uinta Basin. It is entirely possible that this fragment should be referable to one of the characteristic Uinta genera, *Protitanotherium* Hatcher or *Diplacodon* Marsh. Between these two, it is not feasible to make a definite choice, because the fragment might equally well belong to either genus, but I have assigned it to *Protitanotherium*, since that is so very much more abundant individually. That the

Uinta genus should have persisted into the Duchesne River is not at all surprising, but, so far as is known, it did not extend up into the White River.

In this fragment, the first and second molars are very much abraded, so that little of the pattern is discernible; m_2 has a prominent cingulum on the hinder side of the posterior crescent, rising toward the lingual face and dying away upon the buccal. M_3 is very large and but little worn, the talon not at all; evidently, the tooth was erupted much later than m_2; it differs from that of *T. uintensis* in a number of particulars, as follows: (1) Larger size, in the proportion of 83: 76; (2) the two external valleys open more widely outward and in the posterior valley there is a basal pillar, or tubercle, of enamel; (3) the talon is larger and not basin-like, but merely slightly concave; in *Teleodus*, it is much more deeply concave and distinctly basin-like. Comparison of the other molars is impracticable.

The mandible is very little crushed, or deformed, and it is difficult to determine how far the very different appearance of the jaw in *Teleodus* and ?*Protitanotherium* has been produced by the crushing which the former has undergone. The most obvious difference is in the shape of the horizontal ramus; in the best preserved of the *Teleodus* mandibles, the right half of the jaw has suffered comparatively little deformation and may be used for the comparison. The striking contrast with the supposed *Protitanotherium* is in the dorso-ventral shallowness and transverse thickness of the latter; behind m_3, on the dorsal side of the ramus, is a rather deep fossa, bounded by the two *lineae asperae*, which converge upward and unite on the front of the coronoid. To a point beneath the talon of m_3, the ventral border is straight and horizontal; at that point, the border begins to curve downward to the angle and forms a concavity which is much more decided than in *Teleodus* and the angle itself projects father downward and has a thicker and more rugose margin. The masseteric fossa is curiously small and placed high upon the ascending ramus, but little below the level of the condyle. The latter is much extended transversely, but narrow antero-posteriorly; below the condyle, on the hinder side of the jaw, is a postcotyloid process, a knob-like, rugose prominence, which extends obliquely downward and inward. This process could not have had the functions which a somewhat similar projection has on the jaw of a modern rhinoceros, as is made clear by the shape of the postglenoid process, which is found in all the known genera of the brontotheres and is a transverse ridge that could have had no contact with the postcotyloid; furthermore, the latter has no articular surface. The coronoid has lost its proximal end, but was evidently recurved and probably shaped much as in *Teleodus*.

I feel confident that the two mandibles here compared belonged to species of different genera of the same family.

MEASUREMENTS

	C.M. No. 11,996
Lower molar series, length	179 mm.
M_1, antero-posterior diameter	?44
M_1, transverse diameter	31
M_2, antero-posterior diameter	55
M_2, transverse diameter	34
M_3, antero-posterior diameter	87
M_3, transverse diameter	36
Mandible, depth below m_1	58
Mandible, depth below talon of m_3	73
Mandible, thickness, below m_1	38

Horizon: Duchesne River, Halfway substage.
Locality: 12 m. S.W. of Vernal, Utah.

FAMILY **HELALETIDAE** OSBORN

HETERALETES PETERSON

(Pl. II, figs. 4, 4*a*)

Heteraletes Peterson, *Ann. Carnegie Mus.* **21**: 68, 1931.

Generic characters: I_3, C_1, $P?_4$, M_3.

P_2 with low tricuspid crown, P_3 submolariform; P_4 completely molariform; M_1 and M_2 with cross crests and anterior and posterior cingulae [*sic*] as in *Dilophodon* from the Bridger Eocene.

The incisors are fan-shaped, the first and second of subequal size, while the lateral incisor is reduced to almost half the size of those in front. The lower canine is rather low-crowned, but of considerable antero-posterior diameter at the base of the crown. The latter rises to a trenchant point. There is a considerable diastema between the canine and the cheek-dentition, which may possibly be slightly exaggerated [in the figure] due to the mending of the specimen. P_1 may or may not be present. P_2 a comparatively simple crown, consisting of the para-, proto- and metaconids, the protoconid the larger of the three. The crown of P_3 is almost completely molariform; besides the typical paraconid the crown of this tooth has the two complete crosscrests, as in the molars, and there is a well formed cingulum on the posterior face. P_4 has reached the complete molarization with the two cross-crests and well marked cingulum in front and back. The first and second molars are cross-crested with the cingulae [*sic*] in front and back, as in *Helaletes* or *Dilophodon* from the Bridger Eocene. M_3 is rather deeply buried in the jaw. Its detailed structure cannot be correctly described. The mandibular rami are quite heavy, deep, and have a strong symphysis, the posterior border of which is opposite the junction between P_3 and P_4.

Not knowing the detailed structure of M_3, the proposed genus is, with the advanced condition of P_3 and P_4 most nearly like *Dilophodon* of the Bridger Eocene, though smaller than the latter genus.[50]

Peterson's description is sufficient without adding anything further.

Heteraletes leotanus Peterson

Heteraletes leotanus Peterson, *Ann. Carnegie Mus.* **21**: 68, 1931.

As there is but one species assigned to this genus, the measurements are a sufficient description. In the following table, Peterson's figures are quoted (without verification).

[50] Peterson, O. A., *op. cit.* **21**: 68, 1932.

MEASUREMENTS

Length of jaw, incisors to angle of ascending ramus, approx.	95 mm.
Length of cheek-dentition p_2, m_2	33
P_2 length	4.5
P_2 breadth	5.2
P_3 length	6.5
P_3 breadth	4.
M_1 length	6.5
M_1 breadth	5
M_2 length	7
M_2 breadth	5

These dimensions show what a very small animal this type specimen was; it is much the smallest known representative of its family and one of the most diminutive of known perissodactyls; only some of the Eocene horses, *Hyracotherium-Epihippus* were as small.

Horizon: Duchesne River, Randlett substage: "Duchesne Oligocene, near base of series" (Peterson).
Locality: 3 m. N.W. of Leota Ranch, Uinta Basin, Utah.

FAMILY **HYRACODONTIDAE** COPE

MESAMYNODON PETERSON

(Pl. II, fig. 5)

Mesamynodon Peterson, *Ann. Carnegie Mus.* **21**: 71, 1931.
Hyracodon Peterson (*nec* Leidy), *Ann. Carnegie Mus.* **23**: 388, 1934.

I am convinced that Peterson's reference of the jaw fragment, which is the type of the species in this proposed genus, to the Amynodontidae is a mistaken one and, therefore, that the name *Mesamynodon* was not happily chosen; it is unfortunate that the law of priority forbids the substitution of some more appropriate term. I may add that Professor H. E. Wood, the leading authority on the American rhinoceroses, agrees with me in this opinion. I am, further, of the opinion that the specimen named *Hyracodon primus* in Peterson's posthumous paper of 1934, which did not have the benefit of the author's revision, should be placed in a less advanced genus.

The original description of *Mesamynodon* is as follows:

Generic Characters: P_2 vestigial; proto- and deuteroconid [of p_3], which form the main cross-crest, relatively low; paraconid and posterior cross-crest high and more completely developed, when compared with lower premolars of *Amynodon*. Molars as in *Amynodon*, but with cingulum better developed.

In excavating the alveolar border in front of P_3 of the type, a portion of a shallow alveolus with a small fragment of the root of P_2 was found. Judging from this very shallow alveole and the minuteness of the root-fragment this tooth is evidently reduced to a mere vestige in comparison to the already much reduced P_2 of *Amynodon*. In fact the tooth may be entirely wanting in some individuals, indicating a considerable step beyond *Amynodon* toward such forms as *Metamynodon* of the White River Oligocene. The prominence of the cingulum on both premolars and molars of the present specimen strongly suggests *Hyracodon* of the Nebraska-Dakota Oligocene, but P_3 is reduced too much in length, to say nothing of the vestigial P_2, to place the specimen with the *Hyracodonts*. Provisionally I therefore place *Mesamynodon* in the subfamily *Amynodontinae* pending the discovery of better diagnostic material.

I think that Peterson was mistaken in his interpretation of this fossil; its appearance has probably been changed since he wrote the description which is quoted above, for some plaster of Paris has been placed beneath p_3 and the alveole which he believed to be vestigial, has been excavated. *At present*, I can see no reason to regard p_2 as vestigial and the alveole might be that of the posterior root of a two-rooted p_2; p_3 and p_4 are less completely molariform than in *Hyracodon* and this feature, together with the upper premolars, which are not so completely molar-like as in the White River genus, justifies the recognition of *Mesamynodon* as a distinct genus. It is true that, in *Hyracodon*, the molarization of the premolars was subject to great variation in White River times and this has led to the proposal of several different species, but, in none of these variants, are the premolars so little complicated as in the unfortunately named Duchesne River genus.

In the posthumous paper, already referred to, Peterson proposed a new species of *Hyracodon*, naming it *H. primus*, the type of which is a fragment of an upper jaw, with p_4–m_3 in it, C.M. No. 11,914. In this maxillary, only m_2 is complete, the other teeth having lost more or less of their crowns and m^3 is not included in the figure (fig. 8) of Peterson's paper. A second, referred specimen, which Peterson probably never saw (C.M., No. 11,915) has enabled Mr. Horsfall to draw unbroken crowns of p^4 and m^1 and a nearly complete m^3, which lacks the postero-internal portion. The three specimens, upper teeth (No. 11,914 and 11,915) and lower jaw, type of *Mesamynodon medius* (No. 11,672) agree well in size and are probably referable to the same species. If so, the latter name must be used, as having priority.

Upper Teeth.—The two individuals in the Carnegie Museum, Nos. 11,914 (type) and 11,915 (referred) together supply p^4 to m^2 intact and m^3 substantially complete. Peterson describes his "*Hyracodon primus*" as follows:

> In detailed structure the teeth agree most closely with those in *Hyracodon petersoni* Wood, except the less hypsodont crowns; the more prominent external cingulum of P^4, M^1 and M^2; and the greater convexity of the posterior portion of the ectoloph on P^4 and M^1. This convexity of M^2 is much reduced and more nearly approaches the concave external face of the metacone in the molars of *H. petersoni*. The crista of P^4 and the molars are of somewhat greater development than in the White River species.

Under the circumstances, a rather fuller and more systematic account than Peterson's preliminary description seems to be called for.

Upper Teeth.—P^4 is even more molariform than in most examples of *Hyracodon nebrascensis*, but is relatively smaller and lower crowned and the posterior crest is much farther forward, making the hinder valley and enamel pocket correspondingly larger. The

crista likewise is much less prominent, being in an incipient stage; as in the White River species, the lingual end of the anterior cross-crest is recurved and reaches the posterior crest, obstructing the exit of the main valley; the cingulum is prominent on the anterior and posterior ends of the crown, but much less so on the lingual and buccal sides than in *H. nebrascensis*.

The *molars* are very much like those of *Hyracodon*, but with such differences as to make it inadvisable to refer them to that genus. There are also differences between the molars of the two individuals, which arouse some doubt as to whether they both belong to the same species, though I think that these differences are probably fluctuating variations rather than of specific value. In the type-specimen (No. 11,914) m^1, though much worn, shows a distinct antecrochet on the anterior cross-crest, while in No. 11,915 m^1 is without crochets of any sort. M^2 has a prominent and conspicuous crista, but no crochets and m^3 is without crista, or crochet, or antecrochet. In this tooth the external wall is extended behind the posterior crest much farther than in *Hyracodon*, making the crown much more quadrate and less triangular than in the genus last named.

Lower Teeth.—The type specimen of genus and species is a fragment of the left *ramus mandibuli*, in which four teeth are preserved, p_3, p_4, m_1 and m_2; the animal was past maturity, though hardly to be called old, as is indicated by the amount of wear of the teeth. No other specimen, referable to this species, has been found and, thus, nothing is known of incisors or canines in either jaw. The third *premolar*, p_3, is distinctly less molariform than in *Hyracodon*, the anterior crescent being less complete and almost straight and the anterior valley is broader and more shallow. P_4 is smaller than m_1 and the hinder horn of the anterior crescent is less inclined backward, but, otherwise, this tooth has acquired the molar pattern almost completely. The *molars* are very much the same as in *Hyracodon* and display no generic difference from it. As Peterson noted, the cingulum is prominent on both premolars and molars, but in the latter it is faint on the lingual side of the posterior lobe and the likeness, in these respects, to *Hyracodon* is so close, as almost to lead Peterson into referring these fossils to the White River genus.

Beside the teeth, Peterson described and figured a femur and an astragalus, which he provisionally referred to *Hyracodon*. So far as the femur is concerned, this reference is probably correct as to the family, probably not to the genus, which is not known to occur before the White River. As Peterson points out, the femur is like that of *Hyracodon*, but differs in several respects; the shaft is relatively more slender, the great trochanter rises higher above the level of the head and the third trochanter is larger and more prominent and has a rather more proximal position. The reference of the astragalus is very doubtful, but, almost certainly, is not to *Hyracodon* because of the shortness of the neck, which is almost as short as in the horses, the inner condyle extending nearly to the navicular facet, which is not produced beyond the trochlea toward the tibial side.

Mesamynodon medius Peterson

Mesamynodon medius Peterson, *Ann. Carnegie Mus.* **21**: 73, 1931.
Hyracodon primus Peterson, *Ann. Carnegie Mus.* **23**: 388, 1934.

As there would seem to be but a single species, the dimensions afford a sufficient diagnosis. Peterson's measurements of the type of *Mesamynodon medius* contain certain evident typographical errors, but are given here, with the measurements which I made at the Carnegie Museum in November 1941.

MEASUREMENTS

	Mesamynodon medius	
	Peterson	*W. B. S.*
Length of jaw fragment	66 mm.	72 mm.
Depth of ramus at m_1	31	30
Length of p_3	13	14
Breadth of p_3 opposite posterior crest	95* [*sic*]	11
Length of p_4	15	15
Breadth of p_4 opposite post. crest	10.5	11
Length of m_1	17	17
Breadth of m_1 opposite post. crest	12	13
Length of m_2	20	21
Breadth of m_2 opposite post. crest	12.5	14

* Peterson probably wrote 9.5.

Horizon: Duchesne River, Lapoint substage.
Locality: "Titanothere Quarry," 11 m. W. of Vernal, Utah.

Peterson's measurements of the type of *Hyracodon primus* are repeated in the table below without verification.

MEASUREMENTS

	Hyracodon primus
	C.M. No. 11,914
Length of p^4–m^1 approx.	53 mm.
Length of p^4	12
Breadth of p^4	12
Length of m^1, ectoloph measurement	15
Breadth of m^1 opposite metaloph	15
Length of m^2 ectoloph measurement	17
Breadth of m^2 opposite protoloph	17
Breadth of m^2 opposite metaloph	14

It will be observed that the types of *Mesamynodon medius* and *Hyracodon primus* agree quite closely in size and may well belong to the same species.

Horizon: Duchesne River, Lapoint substage.
Locality: about ½ m. W. of Vernal, Utah.

FAMILY **RHINOCEROTIDAE** OWEN

EPITRIPLOPUS WOOD

Prothyracodon Peterson (nec. S. and O.), *Ann. Carnegie Mus.* **12**: 134, 1919.
Epitriplopus Wood, *Bull. Amer. Palaeontol.* **13**: 179, 1927.

In the Uinta stage of the Upper Eocene there occurs a group of fossils, evidently very closely allied, to which three generic terms have been applied, *Prothyracodon*,

Epitriplopus and *Eotrigonias*, all of which may eventually prove to be referable to the same genus. I am keeping them apart, provisionally, until more complete material shall have been found. All of the supposed genera agree in the form of the third upper molar, which differs from that of the hyracodonts and amynodonts and agrees with that of the true rhinoceroses in having the external wall confluent with the posterior crest; a vestige of the outer wall may or may not be present. In consequence, the crown has taken on a trigonal rather than a quadrilateral form. How far this exceptional and characteristic feature of the third upper molar is significant of relationship with the Rhinocerotidae, remains to be determined. For the present, I am including these forms, whether one genus, or two, or three genera, in the true rhinoceroses, though it is quite possible that the resemblance is due to convergence rather than to relationship. Wood, in his paper of 1927,[51] refers *Eotrigonias* to the Rhinocerotidae, *Prothyracodon* and *Epitriplopus* to the Hyracodontidae, a procedure which I cannot accept and I doubt that it represents his present opinion. Peterson overlooked the figure of the *Prothyracodon* dentition which I published in 1890,[52] and which showed that in this genus m^3 is of the trihedral, rhinocerotic type, with the outer wall and posterior crest confluent and the wall behind the crest reduced to a mere wrinkle of enamel. Nevertheless, I think it preferable to employ the three names, rather than to keep shuffling them back and forth, as better-preserved fossils are discovered. It is my present belief that at least two of the three alleged genera will eventually be merged into one, and that the undoubted differences between them will prove to be of no more than specific importance. *Prothyracodon* has a tridactyl manus and, if Wood is right in regarding *Eotrigonias* as ancestral to the White River *Trigonias*, it must have retained the fifth digit in the manus.

Wood's original definition of *Epitriplopus* is as follows:

> The genoholotype is *Prothyracodon uintense* Peterson I_3, $C\frac{?}{1}$, $P\frac{4}{4-3}$, $M\frac{3}{3}$. P^2 has an ectoloph and a single large internal cusp connected with the paracone by a cross-crest. M^2 is very long in proportion to its width. The posterior buttress of M_3 is lost completely except for a trace near the base. The manus is tridactyl.[53]

Epitriplopus medius Peterson

Epitriplopus medius Peterson, *Ann. Carnegie Mus.* **23**: 387, 1934.

Peterson's diagnosis of this species is a comparison with *E. uintensis*, as described by Wood, though the comparison is implicit, not expressed as such.

Specific characters: P^3 with proto- and metalophs slightly separated on the inner face of the crown. P^4 with proto- and metalophs well separated internally; the base of the internal exit of the cross-valley is, however, closed up, forming a large and relatively deep median fossette. Furthermore, there is present on P^4 a very weak crista and a cingulum-like ridge on the posterior half of the ectoloph on M^1, of approximately the same diameter as in *Epitriplopus uintensis*, but with a heavier internal cingulum at exit of the cross-valley. There is a well marked cingulum on the posterior half of the ectoloph in M^1, absent on M^2, while in *E. uintensis* there are no external cingula on the molars. M^2 shorter than in *E. uintensis*.

The measurements which follow are Peterson's, given here without verification.

MEASUREMENTS

Length of cheek-teeth dentition p^3–m^2	59 mm.
Length of p^3, approximately	13
Transverse diameter opposite metaloph	12
Length of p^4, ectoloph measurement	13
Transverse diameter p^4, opposite protoloph	12
Length of m^1, ectoloph measurement	18
Transverse diameter of m^1, opposite protoloph	15
Length of m^2, ectoloph measurement	18
Transverse diameter of m^2, opposite protoloph	17

Horizon: Base of Duchesne River, Oligocene, Randlett horizon.
Locality: Two 2 m. N.E. of Randlett Point, Uinta County, Utah.

FAMILY **AMYNODONTIDAE** S. AND O.

HORACE ELMER WOOD, 2ND.

A new amynodont rhinoceros is one of the most interesting and instructive discoveries made by the Carnegie Museum expeditions in the Duchesne River formation. This long-sought link, now, fortunately, no longer missing, represents the logical continuation of the evolutionary trend visible in the successive stages of *Amynodon* from the North American Upper Eocene (Uintan), and foreshadows the additional specializations found in *Metamynodon*.[54]

It is a close decision whether to call this the most advanced species of *Amynodon*, thereby considerably extending the scope of the genus as previously known and distorting its verbal definition, or to make this a new, transitional genus; the least satisfactory treatment would be to include this form in *Metamynodon*, for which there would be little justification in logic or convenience. Since the decision must be based purely on general convenience, I am glad to defer to the judgment of my former teacher, the author of the rest of this study, and treat this form as a new genus.

It is a pleasure to acknowledge my obligations to Curator J. LeRoy Kay, of the Carnegie Museum, for his kindness in assigning this interesting material to me for study, as well as for numerous other courtesies over a long period; to Professor William B. Scott, for his sympathetic assistance in preparing this manuscript for publication, despite the complications occa-

[51] Wood, H. E., *Bull. Amer. Palaeontol.* **13**: 188, 1927.
[52] Scott, W. B., *Trans. Amer. Philos. Soc.* **16**: pl. XI, figs. 6, 7, 10, 1890.
[53] Wood, H. E., *loc. cit.* **13**: 179, 1927.
[54] Wood, H. E., *Trans. N. Y. Acad. Sci.*, ser. 2, **3**: 86–89, 1941.

sioned by my military service; and to the American Philosophical Society, in Philadelphia, for support of my studies of rhinoceros evolution.

Megalamynodon regalis, gen. & sp. nov.[55]

(Pl. VIII)

Taxonomy: Amynodon, n. sp. (Wood, *et al., Bull. Geol. Soc. Amer.* **52**: 10, 1941; Wood, *Trans. N. Y. Acad. Sci.*, (2), **3**: 87 1941).

Types: type specimen, C.M. No. 11,953, consisting of both maxillae with the upper cheek teeth and the mandible with most of the lower teeth; the rear ends of the mandible with nearly all the molars: referred specimen, C.M. No. 9,961, upper and lower teeth in jaw fragments.

Locality: all three specimens (Field, No. 27/1933) were found in a quarry in the Halfway horizon (or local fauna) of the Duchesne River formation, Duchesnean [56] age (Eocene-Oligocene transition), one mile north and west of Twelve Mile Bridge on U. S. Highway No. 40, twelve miles southwest of Vernal, Uinta County, Utah, by the 1933 Carnegie Museum expedition, under the leadership of J. LeRoy Kay.

Generic and *Specific Diagnosis:* $i\frac{3???}{3-2}$, $c\frac{1}{1}$, $p\frac{2}{3}$, $m\frac{3}{3}$; two upper incisors preserved (probably three originally present), decreasing in size and complexity mesiodistally; upper canine suggests *Metamynodon* except in its much smaller size; buccal aspect of upper premolars suggests *Metamynodon*, but crown view retains most of the simplicity of the *Amynodon* pattern: p^2 is sharply triangular, with the protoloph slanting posteromedially at a small angle with the ectoloph, and a much less prominent metaconule, enclosing a medifossette; p^3 triangular to molariform; p^4 submolariform to molariform; upper molars intermediate in size and character between *Amynodon intermedius* and *Metamynodon planifrons* but nearer the former; i_3 was much larger than the other incisors, judging by the roots; lower canine relatively small, suggesting *Amynodon*, rather than *Metamynodon* or other advanced forms; no trace of p_1 or p_2; p_3 reduced as compared with *Amynodon*, but larger than in either *Paramynodon* or *M. chadronensis;* p_3 slightly simplified and shortened, antero-posteriorly, as in *Metamynodon* (as the anterior tooth of the functional series) but not as much so as in *M. chadronensis*, even; p_4 essentially molariform and not greatly shortened, antero-posteriorly; m_{1-3} much as in *A. intermedius*, i. e., not distorted out of all close resemblance to rhinoceros teeth, especially in the rather smooth (i. e., less swollen) buccal surfaces of m_2 and m_3, in particular, but nevertheless, intermediate between *A. intermedius* and *M. chadronensis.*

DESCRIPTION OF INDIVIDUAL SPECIMENS

Since the left upper tooth row of C.M. No. 11,953, with p^2–m^3, occludes exactly with the lower tooth series bearing the same museum number, the association in a single individual seems indisputable, quite aside from the field label.

This is apparently a young adult, with all the permanent teeth fully erupted, but without serious attrition of the dental patterns. The upper diastema, as shown on the left side, is surprisingly short—only 10.5 mm. long. P^2 has a high protoloph and a low metaconule; its crista is beginning to form a sharp ridge; the valley is not quite open, internally. In p^3, a long crista first runs parallel to the metaconule, then joins it; the median valley is open, lingually. P^4 has a long crista which remains free at its internal end; it also has a metacrista which joins the metaconule, enclosing a pit (which lacks a special name) between metacrista, metaconule and metacone. (This peculiar arrangement is present, on one side only, in this specimen; it also appears on C.M. No. 9,961.)

Only the palatal aspect of the skull, C.M. No. 11,958, has been preserved. The individual was presumably considerably older than C.M. No. 11,953, since most of the distinctive characters of the tooth pattern had been ground away from the occlusal surfaces of the teeth. P^3 has a separate, somewhat puny, metaloph, with the median valley opening lingually. P^4 is fully molariform, or, rather, is like a stunted molar, with the metaloph thinner and lower than the protoloph; it is essentially like p^4 of *Metamynodon planifrons*, except that it is not bulbous. M^1 is wedge- or keystone-shaped, as in an unworn m^1 of *M. planifrons.* The proportions of m^{2-3}, also, are almost as in *M. planifrons.*

As he was unable to make more than a few measurements before leaving for induction in the Army, Professor Wood asked me (W.B.S.) to make them for him and I am, therefore, responsible in the matter. In the following table the term "dimensions" means the antero-posterior by the transverse diameter of a tooth-crown. All the specimens measured are in the Carnegie Museum.

MEASUREMENTS

	No. 9,961	*No. 11,958*	*No. 11,953*
Upper cheek-tooth series, length			204 mm.
Upper premolar series, length			73
Upper molar series, length		147 mm.	144
P^2, dimensions	20×22 mm.		20×26
P^3, dimensions	25×28	26×38	26×31
P^4, dimensions	34×37	31×45	31×40
M^1, dimensions	48×41	50×49	46×42
M^2, dimensions	57×48	59×55	53×44
M^3, dimensions		51×44	49×46

[55] *Megalamynodon regalis:* big + *Amynodon*; *regalis* refers both to the large size, compared with its Uintan predecessors, and to the leader of the field exploration through which this important material was secured, Mr. J. LeRoy Kay.

[56] Wood, H. E., *et al., Bull. Geol. Soc. Amer.* **52**: 10, 19, pl. I, 1941.

Lower dentition, length i_3–m_3			290 mm.
I_3, dimensions			13×12.5
Lower canine, dimensions			24×16
Lower cheek-tooth series, length			217
Lower premolar series, length			88
Lower molar series, length		141 mm.	134
P_3, dimensions	21×14 mm.		22×17.5
P_4, dimensions	30×20		30×19
M_1, dimensions	39×23	49×21	39×23
M_2, dimensions	48×27	54×22	44×25
M_3, dimensions		53×27	51×26
Skull, breadth over zygomatic arches		298	
Palate, width at m_2		92	
Occiput, breadth over parocc. processes		141	
Occipital condyles, breadth		116	
Mandibular angle, breadth to m_3		170	
Mandible, height of condyle		181	
Mandible, height of coronoid		222	
Mandible, depth of ramus at m_2		68	

Horizon: Duchesne River, Randlett substage.
Locality: 1 M. N. & W. of 12 Mile Bridge, U. S. Highway No. 40, 12 M. S.W. of Vernal. Uinta Co., Utah.

CONCLUSIONS

The morphological and evolutionary position of this form is self-evident:[57] it falls into a "previously prepared position" in an unusually simple ("monophyletic") evolutionary sequence, intermediate between *Amynodon intermedius* Scott and Osborn, typical of Uinta C. and *Metamynodon chadronensis* Wood, from the Chadron formation, which latter species, unfortunately, is known only from the lower jaw. In a broader sense, it is an annectant form between the genus *Amynodon*, typical of the Upper Eocene (Uintan), and the Oligocene *Metamynodon*. All details of its structure fit into this generalization in an unusually harmonious evolutionary picture, without distortion of any kind—not even that of distorted coördinates.

ADDITIONAL NOTES ON *MEGALAMYNODON*

W. B. SCOTT

Professor Wood's induction into the Army has prevented him from preparing a more extended and detailed account of these most interesting fossils, which are surprisingly abundant for the Duchesne River; next to *Teleodus*, the individuals referable to this genus are more numerous than those of any other of the fauna. In the Carnegie Museum are two individuals which, considering the variety and generally fragmentary condition of the Duchesne River fossils, may fairly be called well preserved. The first of these (C.M. No. 11,953), which Wood has selected as the type of his proposed genus and species, *Megalamynodon regalis*, consists of the superior maxillaries, right and left, each of which retains all of the grinding teeth; two upper incisors, i^2 and i^3, of the left side, and the right upper canine were found detached, but evidently belonging to the same individual. In addition there is a mandible with symphysis and both horizontal rami, but lacking the ascending rami of both sides. On one side, or the other of this jaw are preserved the lateral incisor (i_3), the canine and all the cheek-teeth. The dentition is, thus, very completely represented.

The second specimen referable to this genus is C.M. No. 11,958, which Wood makes the paratype of his new genus and species. This second individual consists of the finely preserved (relatively speaking) *basis cranii*, with bony palate forward to p^3, and both zygomatic arches, undistorted; all of the cheek-teeth except p^2 of both sides, are retained in position. The anterior part of the lower jaw, including the symphysis and both horizontal rami in front of the molars, is missing, but the right and left ascending rami on both sides, with condyle and coronoid, are nearly complete. Several other more or less fragmentary specimens of jaws, with teeth, are in the collection, but add little to our knowledge of the genus.

Megalamynodon is decidedly larger than the Uinta species of *Amynodon*, but much smaller than the typical species, *Metamynodon planifrons*, of the White River, though the dental formula is the same, except for the incisors, as in the latter. Among the most characteristic features of the family, which, so far as North America is concerned, culminated and ended in the White River, are: (1) the great shortening of the facial region of the skull; (2) the shortening of the nasal bones, with long downward extension of the ventral borders *inside* of the premaxillaries; (3) the shortening of the premaxillae, which extend but little in front of the canines, but their anterior faces are much widened, which broadens the whole muzzle; (4) the shape of the anterior nares is greatly changed,[58] widening transversely and narrowing much dorso-ventrally, thus giving a very different aspect to the view of the skull from in front; (5) the zygomatic arches are greatly expanded transversely and become broader dorso-ventrally and thicker transversely, giving to the skull, especially when seen from the front, much the appearance of a large carnivore; this resemblance is farther increased by the long and very prominent sagittal crest.

In the course of its known history, from the Washakie up through the Uinta, Duchesne River and White River, the teeth underwent considerable modification, each of the three genera in the ascending series, *Amynodon-Megalamynodon-Metamynodon*, displaying a characteristic stage of the change.

The successive steps of modification in the *dentition* are as follows: (1) The incisors, especially those of the upper series, grew steadily smaller and, in *Metamynodon*, they were reduced in number and would seem to have been functionless, which, apparently, was not

[57] Wood, H. E., *Trans. N. Y. Acad. Sci.*, Ser. 2, **3**: 86–89, 1941.

[58] Scott, W. B., *Trans. Amer. Philos. Soc.* **28**: 847, fig. 140, 1941.

true of *Megalamynodon*. At all events, the progressive reduction of the incisors had reached, in the latter, a stage intermediate between the Uinta and the White River representatives of the family.

The only incisors preserved in the Duchesne River material belong to C.M. No. 11,953 and are the left i^2 and i^3, the crown of i_3 and the roots of i_1 and i_2, also of the left side. The second upper incisor is very small and has a simple, antero-posteriorly compressed, conical and acutely pointed crown, without cingulum, and long, cylindrical root. I^3 is much larger and the compressed-conical crown is complicated by a prominent lingual cingulum, which encloses a groove between itself and the body of the tooth; the borders of the crown, mesial and lateral, are slightly, but distinctly raised and there is also, on the lingual side, a conspicuous, low ridge, which runs up from the cingulum to the mesial border, enclosing a shallow-enamel pocket. The root of i^3 has a diameter two or three times as great as that of i^2 and of a different shape, being strongly compressed laterally.

Of the lower incisors, only i_3 retains its crown; this is obliquely procumbent, simply conical in shape and antero-posteriorly thick and with a strong cingulum on the lingual face, which bears obscurely marked ridges; the root is stout and laterally compressed. As indicated by the alveoli, this is much the largest of the lower series. Of the other lower incisors, only the alveoli remain, but these suffice to show the relative size and shape of the roots; i_1 is much the smallest of the series and the cavity is very narrow transversely. The root of i_2 was evidently larger than that of i_1 and of cylindrical shape.

One of the most striking features of *Metamynodon* is to be seen in the large, hippopotamus-like tusks, upper and lower, which were obviously rootless and grew from permanent pulps. In *Amynodon*, the tusks, though effective and formidable weapons, were yet relatively much smaller than in the White River genus and are rooted. The Duchesne River genus, *Megalamynodon*, is intermediate in the character of the tusks between the Uinta and the White River genera; the upper canine is actually and relatively much larger than in the former, far smaller than in the latter, and almost certainly grew from a permanent pulp. The lower canine is proportionally smaller than the upper one, though larger than in *Amynodon*, and seems to have a root; at all events, the enamel ceases definitely at a level above the base.

To Wood's description of the grinding teeth, I need add only a comparison with those of the Uinta ancestor and the White River descendant of *Megalamynodon*. The *premolars* of the latter number two, which is one less than in the Uinta genus and the superior ones are larger and have a stronger cingulum; on both p^3 and p^4 the anterior cross-crest is complete, but the posterior one is divided in unworn teeth. In *Metamynodon* the premolars are still further reduced in size, but except for the convex external lobes, p^3 and ^{4} are more perfectly molariform and have complete crests. In the lower jaw, the premolars are still two in number and are even smaller proportionally. The progressive relative reduction of the premolars in this series is as below.

Like the premolars, the molars are intermediate in character between those of the Uinta and those of the White River genera; in the latter the molars have become very large and high-crowned, suggesting that this series would eventually have developed hypsodont teeth, had the family not become extinct.

EXPLANATIONS OF THE PLATES

PLATE I

FIG. 1. *Eosictis avinoffi* gen. et sp. nov. type; C.M. No. 11,847; right maxillary, with *c*–p^4, lingual side, slightly enlarged.
FIG. 2. *Eosictis avinoffi;* fragment of right squamosal, with glenoid cavity, from outer side. C.M. No. 11,347, slightly enlarged.
FIG. 3. *Hessolestes ultimus*, type; C.M. No. 11,763; fragment of right *ramus mandibuli*, lingual side, with m^2, × 9/10.
FIG. 4. *Poabromylus kayi*, type; lower dentition, buccal view, slightly enlarged.
FIG. 4*a*. The same, crown view.
FIG. 5. *Pentacemylus progressus* type; C.M. No. 11,865; upper molars, crown view, left side, × 5/2.
FIG. 6. *Pentacemylus progressus*, lower teeth, p_4–m_2, crown view, × 5/2.
FIG. 7. *Epihippus intermedius*, type; C.M. No. 11,845, right *ramus mandibuli*, with i_1–m_2, outer view, nearly natural size.
FIG. 7*a*. *Epihippus intermedius*, type; lower dentition, crown view.

PLATE II

FIG. 1. *Protoreodon tardus*, sp. nov., type; C.M. No. 12,049, skull top view, × 1/1 ?Duchesne River, Beaver Divide, Wyo.
FIG. 1*a*. *Protoreodon tardus*, the same, upper dentition, crown view, × 1/1.
FIG. 2. *Camelodon arapahovius*, type; upper cheek-teeth A.M.N.H. No. 14,604, Beaver Divide, Wyo. × 7/5.
FIG. 2*a*. *Camelodon arapahovius*, type; lower cheek-teeth, crown view, × 7/5.
FIG. 3. ?*Hypertragulid*, C.M. No. 10,199, p^3–m^1, crown view, × approximately 3/1.
FIG. 4. *Heteraletes leotanus*, type; C.M. No. 11,849; lower jaw left side, with i_1–m_3, × approximately 3/1.
FIG. 4*a*. The same, lower dentition, crown view.
FIG. 5. *Mesamynodon medius;* upper cheek-teeth, crown view, × 6/5.

PLATE III

Mesagriochoerus primus

FIG. 1. Skull, left side, C.M. No. 12,080.
FIG. 1*a*. Skull, base.
FIG. 1*b*. Lower dentition, crown view, i_1–m_3.

All figures natural size.

PLATE IV

FIG. 1. *Mesagriochoerus*, sp. A.M.N.H. No. 22,558, upper cheek-teeth, $dp.^3$ and ^{4}, m^1, crown view, × 12/5.
FIG. 1*a*. The same, buccal side, × 12/5.
FIG. 2. *Mesagriochoerus* sp., lower teeth, $dp_{3,4}$, m_1, crown view, × 12/5.
FIG. 3. *Diplobunops crassus* sp. nov. type; C.M. No. 2,967, skull, base, × 8/11.
FIG. 4. *Mesamynodon medius;* C.M. No. 11,762; fragment of mandible, left side, with $p_{3,4}$, $m_{1,2}$, × 8/7.
FIG. 4*a*. The same, crown view.

PLATE V

Diplobunops

FIG. 1. *Diplobunops crassus*, C.M. No. 11,301; skull, left side, × approximately 8/11.
FIG. 1*a*. The same, skull, top view, × approximately 8/11.
FIG. 1*b*. The same, skull, base, × approximately 8/11.
FIG. 2. *Diplobunops uintensis*, lower front teeth, ventral side, Uinta formation. P.M. No. 14,252.

PLATE VI

Brachyhyops wyomingensis

FIG. 1. *Brachyhyops wyomingensis*, type; C.M. No. 12,048; skull, side view.
FIG. 1*a*. The same, skull, base.
FIG. 1*b*. The same, top view.
FIG. 1*c*. The same, rear view.

All figures × 13/23

PLATE VII

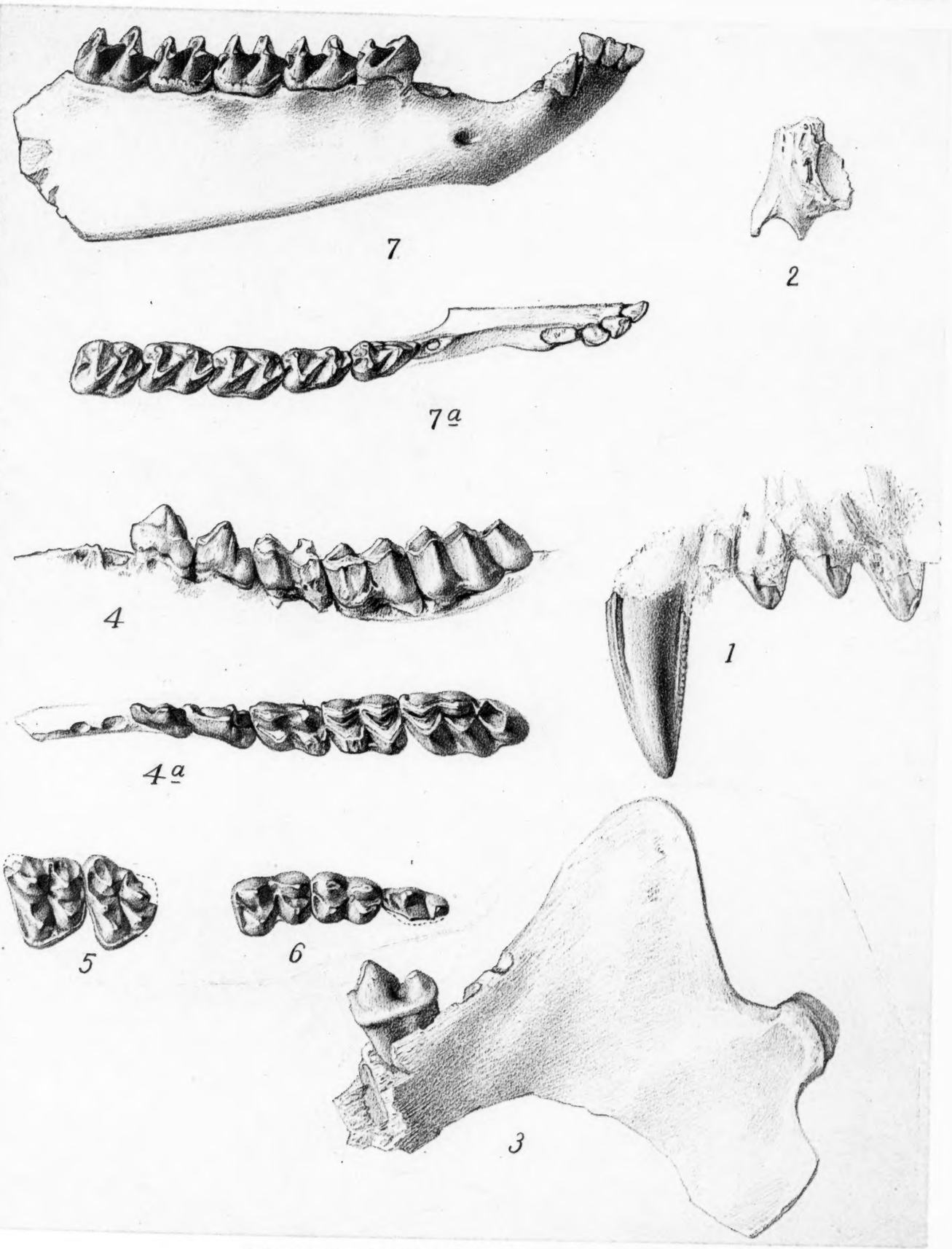
Teleodus uintensis

FIG. 1. *Teleodus uintensis*, skull, left side, C.M. No. 11,759, teeth, No. 11,866 × approximately 3/10.
FIG. 1*a*. The same, base, × approximately 3/10.
FIG. 1*b*. The same, top view.
FIG. 2. The same, mandible, left side, C.M. Nos. 11,761 and 11,809, × approximately 3/10.
FIG. 2*a*. The same, crown view.
FIG. 3. The same, left astragalus, × approximately 1/2.

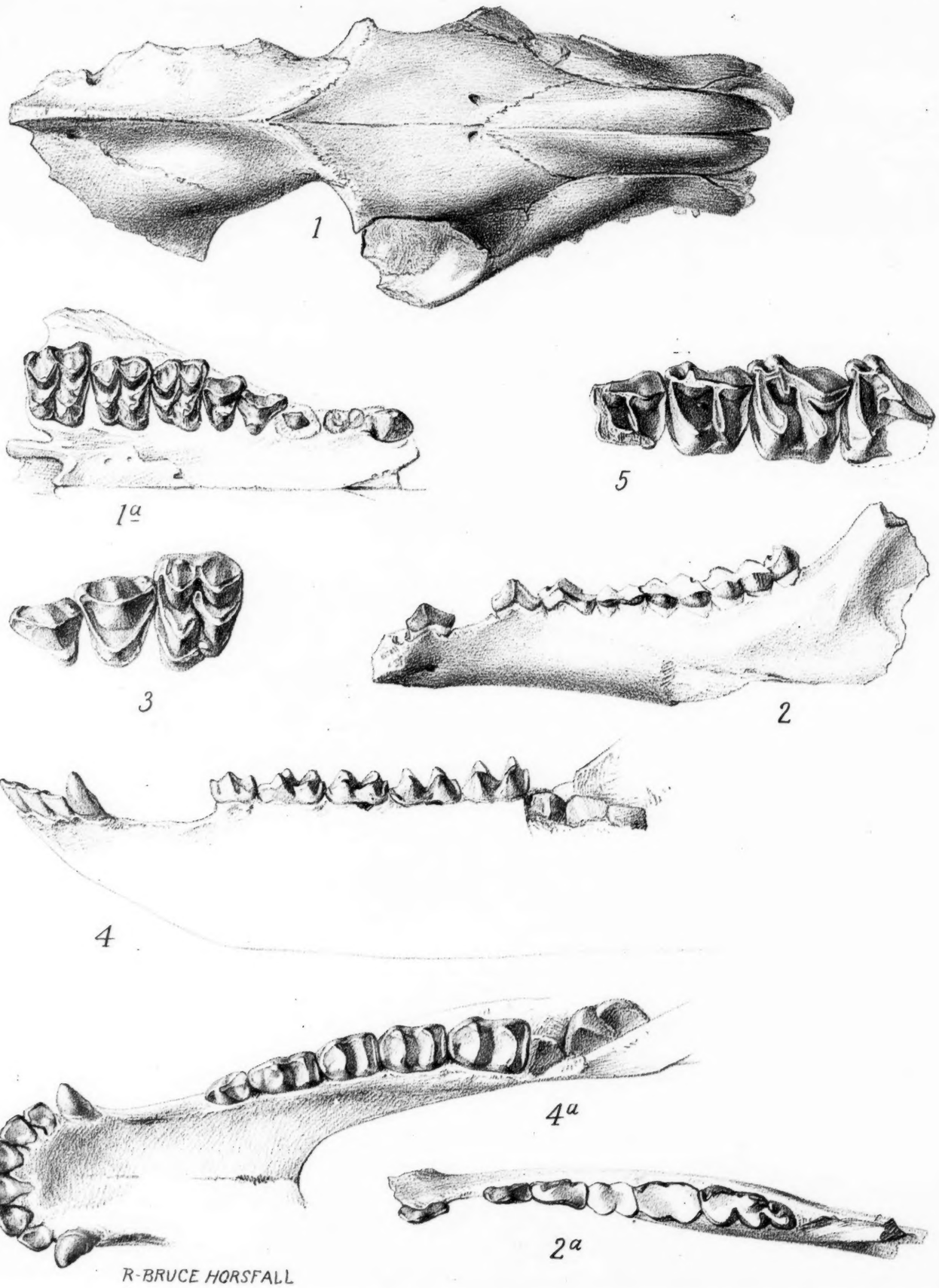
PLATE VIII

Megalamynodon regalis

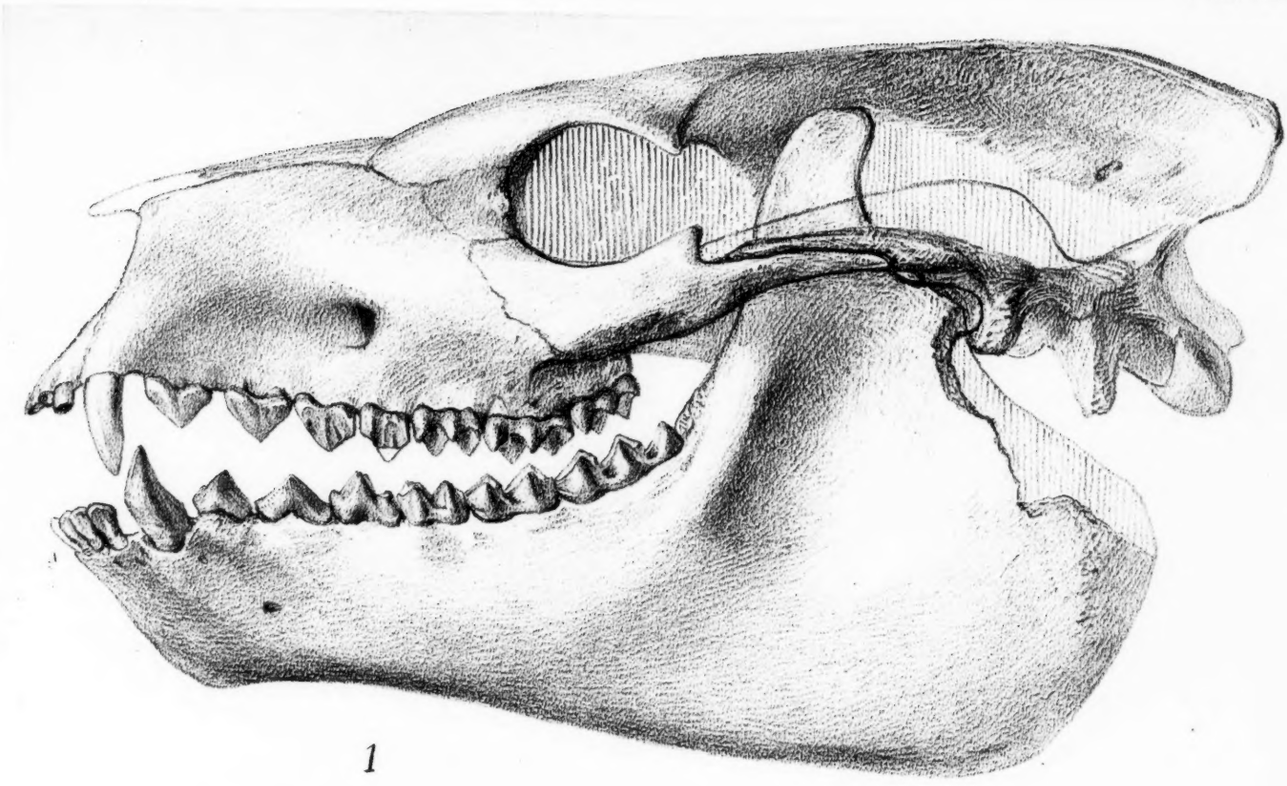
FIG. 1. *Megalamynodon regalis*, type, C.M. No. 11,958, skull, base, × approximately 1/3.
FIG. 2. *Megalamynodon regalis*, mandible left side, C.M. Nos. 11,953 and 11,958.
FIG. 2*a*. *Megalamynodon regalis;* upper dentition, right side, crown view, × approximately 1/3. C.M. No. 11,953.
FIG. 2*b*. The same, lower dentition, crown view, × approximately 1/3.
FIG. 3. The same, upper incisors ^{2} and ^{3}, from behind.
FIG. 4. The same, left upper canine, lingual side.



EOSICTIS, HESSOLESTES, POABROMYLUS,
PENTACEMYLUS, EPIHIPPUS



PROTOREDON, CAMELODON, HYPERTRAGULID,
HETERALETES, ? HYRACODON



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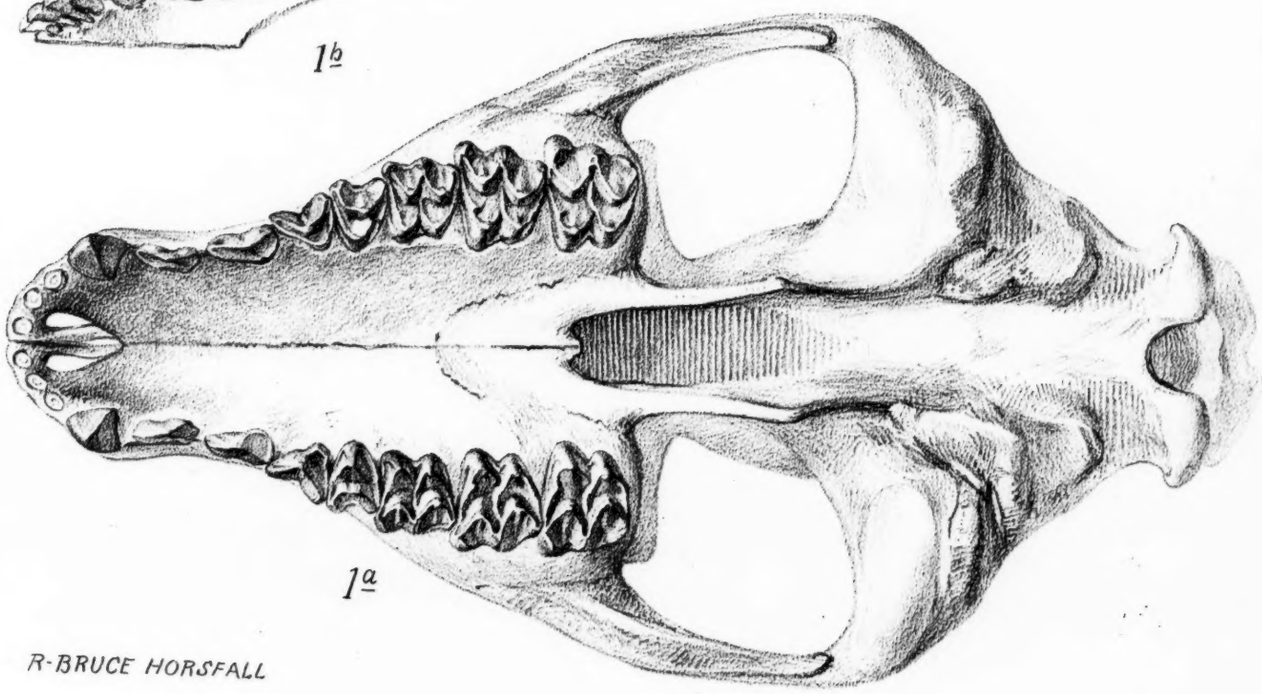
1b



1a

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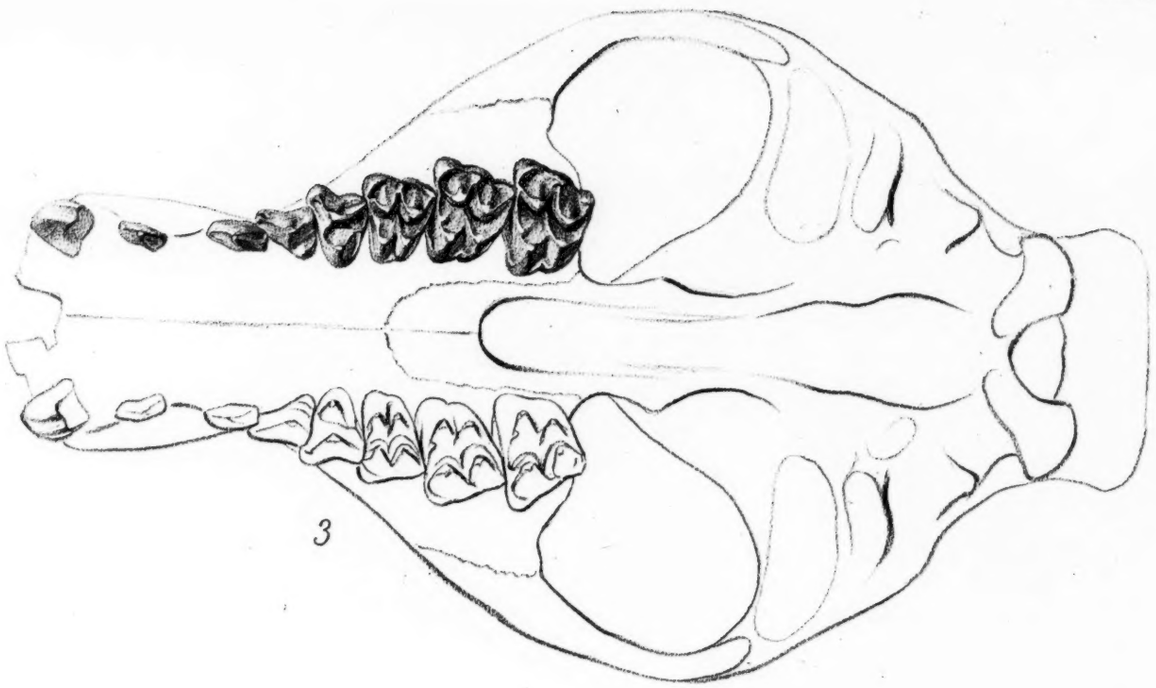
MESAGRIOCHOERUS

PLATE IV



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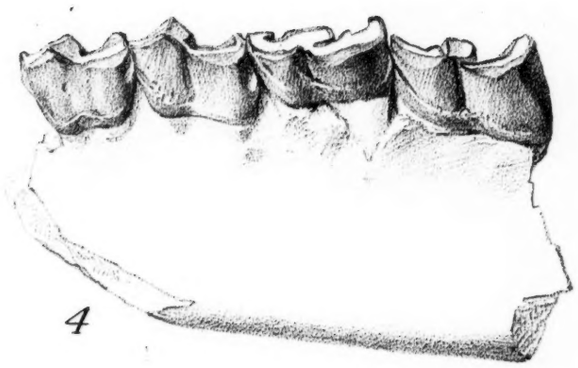

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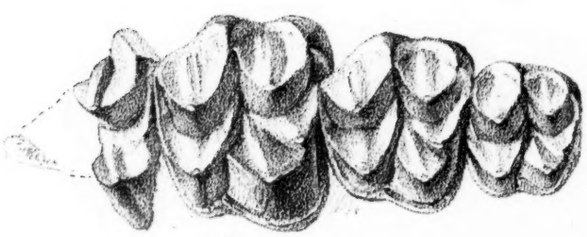

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1a

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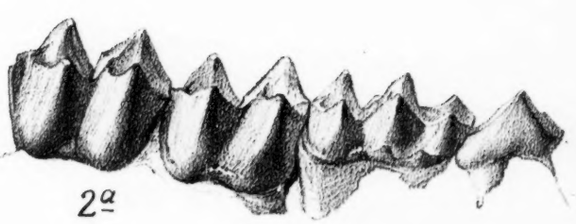
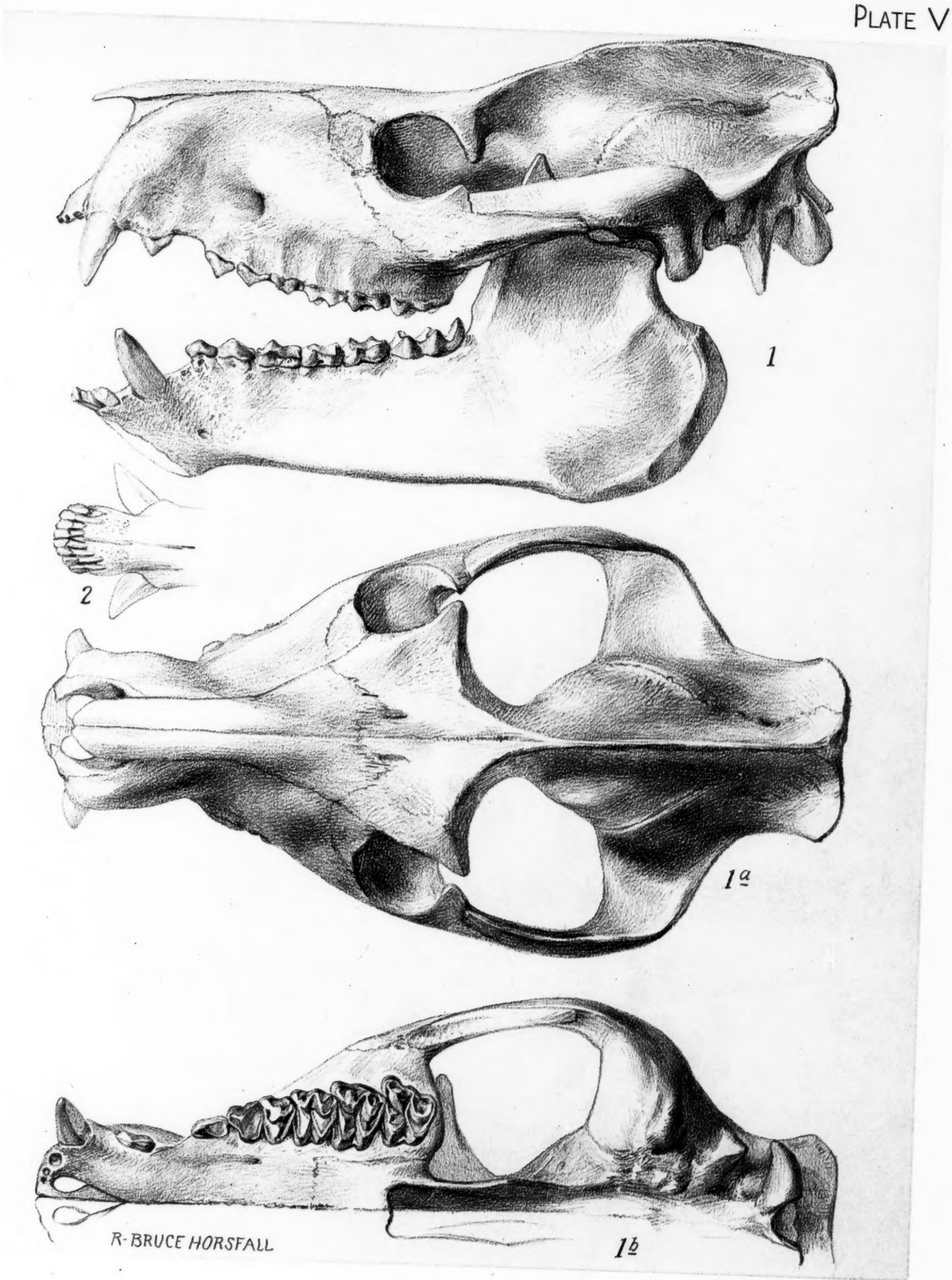


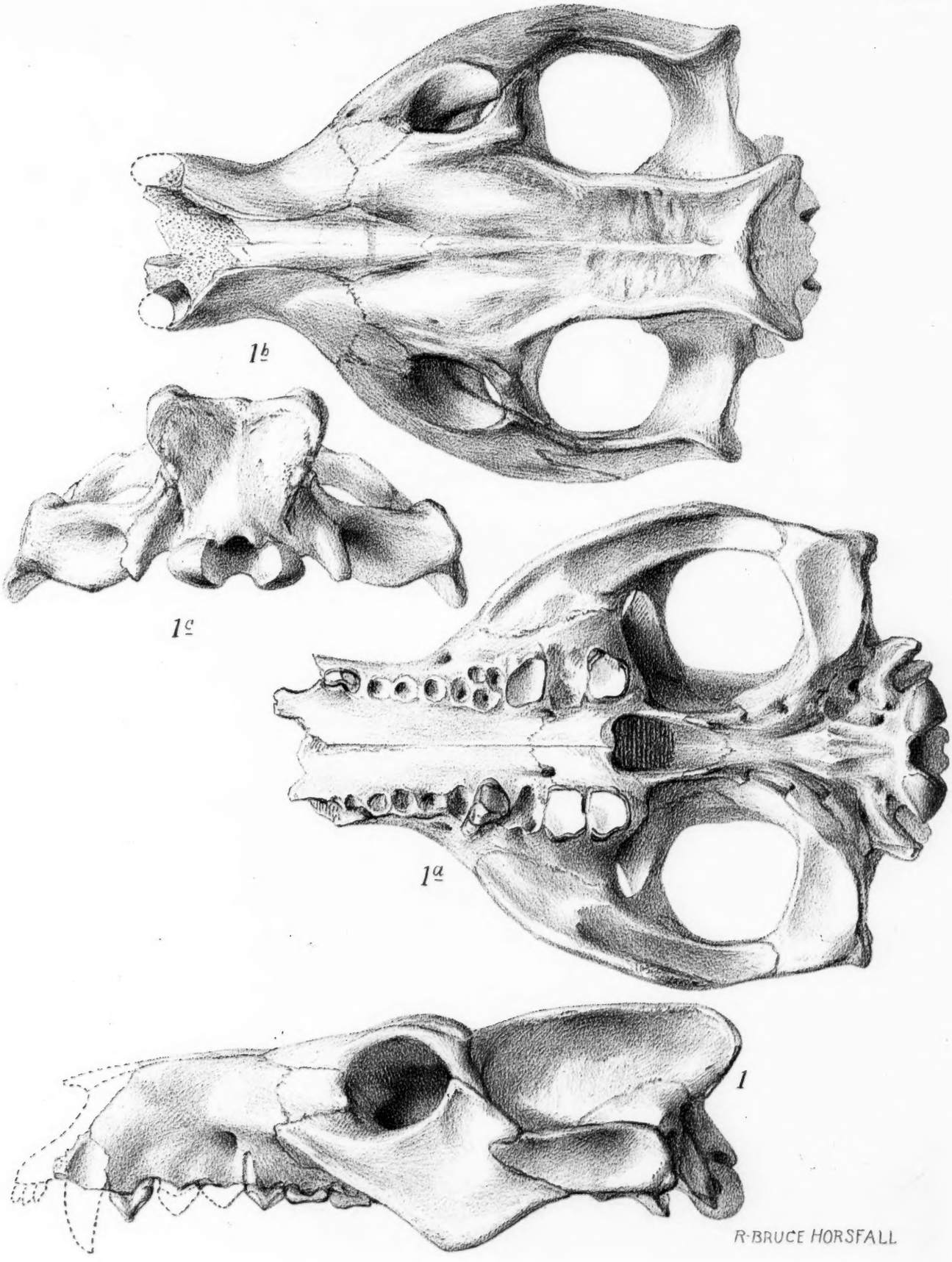
2a

MESAGRIOCHOERUS, DIPLOBUNOPS, ? HYRACODON



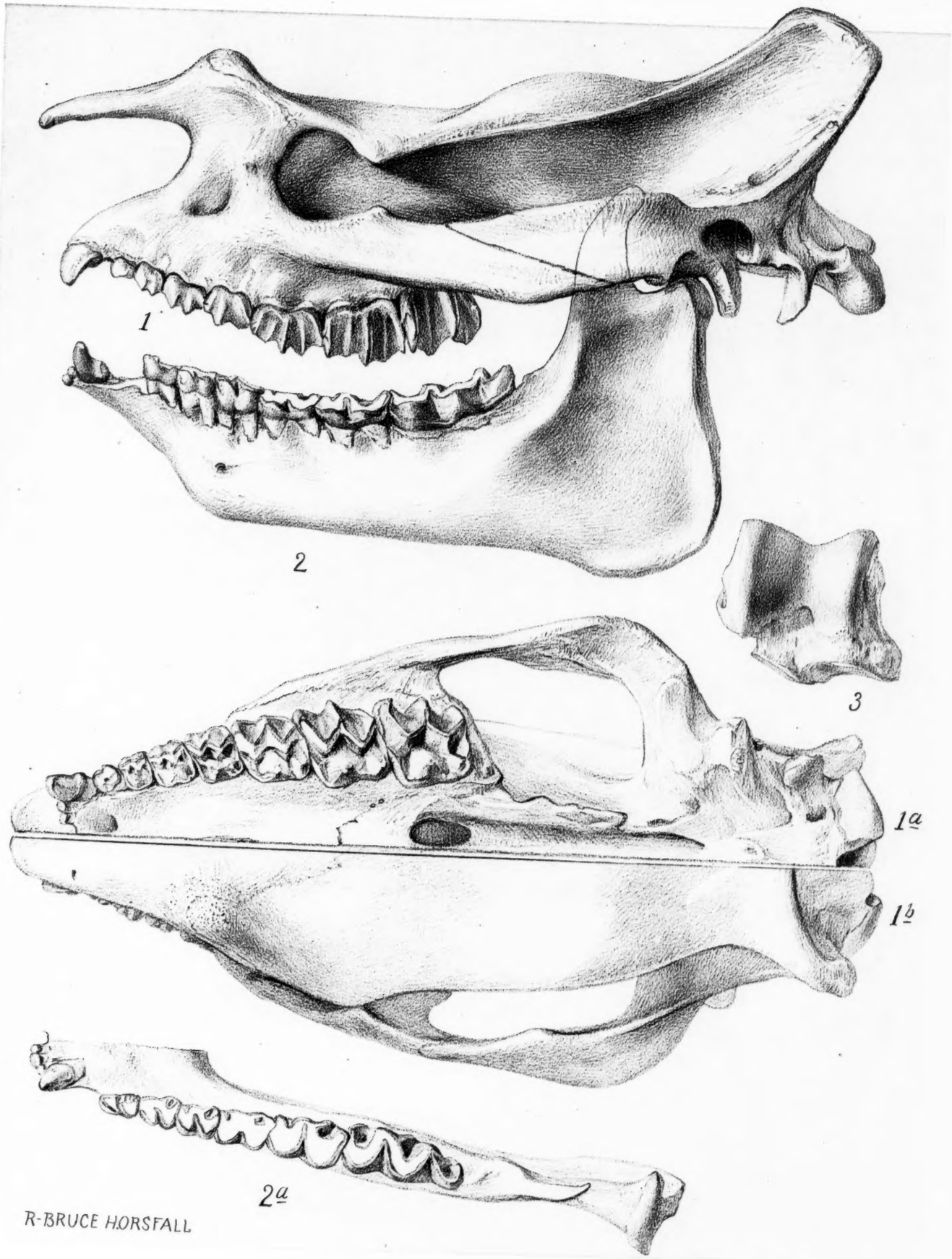
DIPLOBUNOPS

PLATE VI

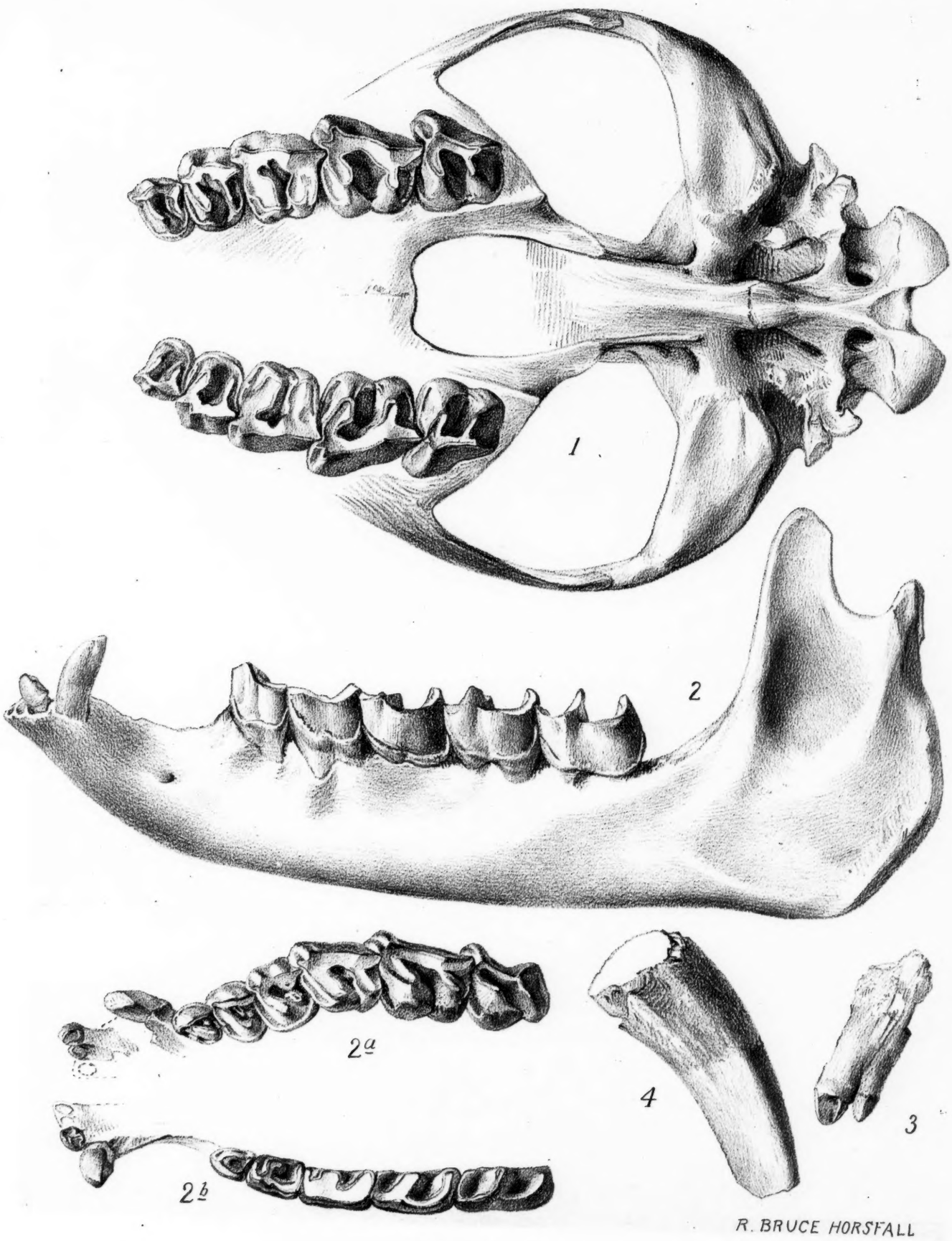


BRACHYHYOPS

PLATE VII



TELEODUS



R. BRUCE HORSFALL

MEGAMYNODON

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